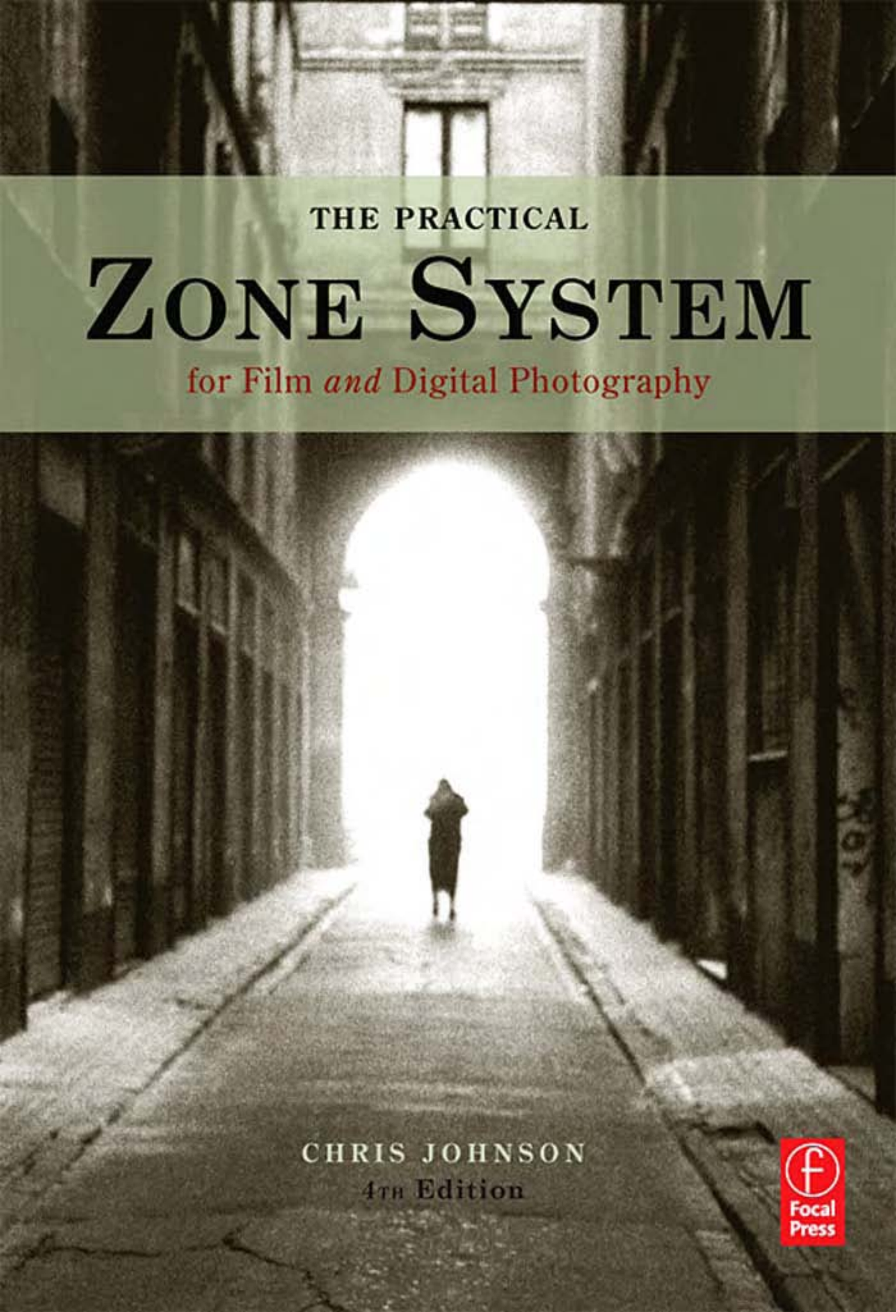

THE PRACTICAL

ZONE SYSTEM

for Film *and* Digital Photography

CHRIS JOHNSON

4TH Edition

Focal Press

THE PRACTICAL
ZONE SYSTEM

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THE PRACTICAL
ZONE SYSTEM
for Film *and* Digital Photography

Fourth Edition

A Simple Guide
to Photographic Control

CHRIS JOHNSON

ELSEVIER

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Preface to the Fourth Edition

I began the Preface of the third edition of this book by writing "Much has changed in the years since 1986 when this book was first published."

Back then the arrival of a few new films and developers seemed extremely important because the essential nature of photography had remained the same for a very long time. Given the state of things now, those words seem almost comically understated. Digital technology is revolutionizing photography in ways that are so fundamental and at a pace this is so rapid that most photographers are either alarmed, or feel as if they are witnessing a remarkable dream.

Some photographers are reluctant to make the transition to digital methods because they instinctively dislike working with computers and monitors and love the process of darkroom printing. But of course photography has always had highly technical aspects and other photographers are attracted by the opportunity to explore the precision and control that digital processes offer.

The point is we now have choices that were unimaginable not very long ago. Those of us who knew and worked with Ansel Adams know that he would most likely have been at the forefront of this revolution, just as he was when Polaroid materials became available. In fact he was quoted in 1980 as saying that "I actually feel that in the next few years — it won't be very long — the electronic image is really going to be the medium in photography."

The reason all of this matters is that the beauty and quality of digital prints can be astonishing!

But one of the ironies of photography's digital revolution is that many people assume that working with Adobe Photoshop and digital printers necessarily means leaving behind many of traditional photography's fundamental methods, skills, and even some of its values. This new edition was written to demonstrate that this is definitely not true; especially when it comes to the Zone System.

Another myth of digital photography is that it instantly makes the process of shooting and printing effortless and almost automatic.

The truth is that the ability to control the process in such exquisite detail sometimes encourages us to settle for nothing less that absolute perfection; this can consume huge amounts of time! Also, every step in the process requires careful attention and enough understanding of the concepts and principles involved to avoid time-consuming and frustrating mistakes. This is where the Zone System can become an essential tool.

It's customary to think of the Zone System as being strictly related to film exposure and development. In fact, although this may sound grandiose, the Zone System can actually be a way of seeing the world with applications in every form of photography, including digital.

A good example of this is the way I work with students learning studio lighting. In general, studio-based photographers rely on incident light meters and Polaroid (and now digital video feeds)

to preview their images before making exposures. But, because my students have learned the language of the Zone System, I can ask them what "zone" they want a background to be and they can not only visualize specific tonal values through these concepts, they also know how to adjust the meter readings they get to achieve the results they want.

The Zone System is powerful and flexible and many experienced photographers have developed personal working methods that are essentially variations of the Zone System, sometimes without even realizing that this is true. (Appendix U contains a number of examples of how the Zone System can be applied to a wide variety of different photographic approaches.)

Until Ansel Adams (in collaboration with Fred Archer) formulated the Zone System, a serious student only had two choices: either study sensitometry at a professional school or stumble along learning how to solve problems by trial and error. The Zone System has done away with all of that. But unfortunately, over the years, the Zone System has gained a reputation for being highly technical and a complex waste of time. Happily this isn't true.

The fact is that Zone System can be very easy to learn and practical to use if it's approached in the proper way.

After teaching hundreds of students, I can confidently say that if you have learned how to develop a roll of film, you can learn to master the Zone System. To make this fact instantly clear to my students, I've made a routine of asking them who is the most confused about photographic technique. I then take this person outside and when we come back after no more than 2 minutes, they are able to demonstrate, using Polaroid film, a mastery of exposure that never fails to amaze the rest of the class.

I'm able to do this by using an extreme form of the approach used in this book: I simply show them how to use my modified spot meter without bothering to explain why it works the way it does.

An analogy could be made to learning how to drive a car. It could be argued that one should begin driving lessons by carefully explaining in detail how internal combustion engines work, what gear ratios mean to the transmission of mechanical energy from the pistons to the wheels, and so on. This is roughly equivalent to teaching students approaching the Zone System about logarithms, characteristic curves, and sensitometry.

The problem is that after you have finished explaining these subjects in detail, what has the student really learned? Have you really completely explained the processes involved? Are there not always ever more subtle and deeper questions of engineering and physics that you have glossed over because you have decided that they are not important? There will always be people who want to know more, and at some point all educators need to draw a line at what they think students need to know before sending them off to experiment on their own.

My approach to writing this book has been to avoid trying to explain all of the science behind the Zone System. Instead I teach all of its basic principles and the logic of how it applies to real life.

I realize that some will find this approach not rigorous enough, but after years of teaching the Zone System to beginning students, my experience has been that once you understand enough to begin achieving consistently good results, the confidence you will gain from that accomplishment will carry you through the learning process to the level of skill you need for your work.

There are a number of excellent, more detailed technical books on the Zone System that should be read by those who favor a scientific approach to their work, and some of them are listed in Appendix S under the section headed Technical Books.

The second question this book addresses is: What information do you really need in order to apply the Zone System to your own photographic problems?

The answers to this question are contained in Chapter 9, "Zone System Testing: Method 2." Here you will find the results of tests that I and a good friend conducted on many different films in a variety of different developers. (See Appendix F for a description of our testing method.) These tests, which made use of all of the major products, were conducted under actual shooting conditions. We then spent time field-testing these results in a working photolab and with my students at the California College of the Arts to assure their accuracy. Appendices E and G contain comprehensive descriptions of the characteristics and uses of all of these products.

My hope is that by updating and expanding this information, and adding discussion on subjects such as digital photography and printing controls, this book can remain a truly practical guide to the Zone System.

As you begin this text, keep in mind that the Zone System is not intended to be an end in itself, any more than is the study of medicine. Learning any new technique necessarily involves an ordering and restructuring of the way that you perceive the world. The beauty and the real value of the Zone System unfolds in the practice of actually using it to create meaningful images. The problem is trying to create with no system at all.

As you begin to use the Zone System you will find yourself modifying and adapting it to best serve your own needs. As this happens the Zone System will become less formal and more a natural part of your creative life.

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How to Read this Book

For those who are just beginning photography, I'd suggest that you start by reading A Primer on Basic Photography at the end of this book. The primer will acquaint you with most of the language of basic photography and will generally make it easier for you to understand some of the new concepts that you will learn.

Note: Readers familiar with other writing on this subject know that the terms "previsualization" and "visualization" are both used among Zone System speakers to describe the act of mentally picturing the photographic subject as the finished print. Also, the words "contraction" and "compaction" are both used to describe the process of reducing negative contrast. After much thought, and because Ansel Adams used these words, I have decided to use the terms previsualization and contraction throughout this book.

This edition begins by carefully explaining what the Zone System is and how it works before dealing with how it applies to film and digital photography. Most people should read the first six chapters to learn the basic vocabulary and concepts that make the Zone System unique. If you are already completely familiar with the Zone System and simply want to know how it applies to your digital work, you should skip ahead to Chapter 10: The Zone System and Digital Photography.

One final question: How does all of this apply to the bewildering array of equipment choices available to photographers these days?

In this book what I have done is begin by outlining concepts and principles that are broad enough to include many different applications. Then, rather than trying to explain how these concepts apply to every conceivable camera, film, and software choice available, what I do instead is lay out what I've learned about how to achieve fine results with the limited selection of materials and processes that I've mastered. What you'll find is that these methods inevitably apply to many other tools and platforms but in specific ways you may have to figure out for yourself. This has always been true for photography, but even more so now that things are changing so fast.

My hope is that this book will make it easy for you to achieve your goals with either film or digital photography. Photography as a creative process is challenging enough without having to struggle with technical issues. Anything we can do to gain more control over this process is worth the effort and this is what the Zone System is all about.

Acknowledgements

This book could never have been completed without the advice, generosity, and support of my friends and students and Marti Schoen who created the drawings for the first edition. I would like especially to thank Steve Dunham for helping to formulate the basic approach presented here.

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I would also like to again thank Arlyn Powell and David Guenette for their patience and support in the publication of this book's first edition.

As long as I can earn enough to pay my taxes I'll be happy.
I'm not a professional photographer you know, I'm an amateur.
"Amateur" is the French word for lover.

— Imogen Cunningham

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CHAPTER 1

"WILL IT COME OUT?"

During a portion of a fourteen years experience as an amateur photographer, I always supposed that a good judgment, combined with experience (the latter implying the generous use of time and plates), would eventually enable me to obtain a good negative every time I exposed a plate. . . . That was my greatest mistake

. . . From "My Greatest Mistake".

—by William Bullock

Bulb and Button Magazine, Sept. 1900

Introduction

The loneliest people in the world are probably photographers in darkrooms waiting to see if their negatives will turn out the way they would like. Add to this the frustration of trying to make a fine print from a bad negative, and it is easy to see why uncertainty about photographic technique can be a major stumbling block to beginning photographers. The anxiety that you may have lost an important image goes a long way towards explaining the proliferation of automatic cameras and, more recently, digital photography that provides instant confirmation that your image is worth saving.

A related issue to consider is the fact that very often, the most imaginative and effective rendition of a photographic subject is not one that simply records what the photographer saw in a simple or literal way. The works of artists like Bill Brandt or Wynn Bullock (not related to the above cited author as far as I know) are dramatic examples of this principle. Direct translations of the visual world are often lifeless and boring.

The problem is that automatic point and shoot cameras are wonderful for casual photography but are too limited for serious creative work. The instant thumbnail images provided by digital

cameras would seem to be a perfect solution to this problem, except for the fact that you only get to see the image after the "decisive moment" has already passed.

What every photographer needs is a clear and direct working method that allows for creative photographic seeing and produces predictable results. The Zone System is specifically designed to do just that. When used properly, it will allow you to deal confidently with any exposure or development problem you are likely to encounter, regardless of the kind of photography you intend to do.

Anyone familiar with the work of Ansel Adams or Minor White knows how powerful a creative tool the Zone System can be. Until now, the problem has been finding a way of making the Zone System understandable to photographers who are not technically inclined.

The irony is that in practice, the Zone System is remarkably easy to use. I discovered this after spending almost two years wading through the available literature and experimenting with homemade densitometers.

Somewhere along the way, I developed a personal way of working that was pure Zone System but bore little relation to the Herculean effort required to learn it.

When I began teaching photography, I quickly discovered that if I taught my students what I did in the field, instead of boring them with the complicated details of why it worked, it was as easy for them to learn the Zone System as it was for me to use it. In other words, it is not the system itself that confuses people, but rather the highly technical details some people use to explain it.

The Zone System can give you a completely new way of photographically seeing the world around you. When you begin using it, the path between what you see or can imagine in front of the camera and what you get in your prints becomes very clear and direct.

Let's consider a number of questions that beginning students usually ask at this point.

Q: What exactly is the Zone System?

A: Basically there are two technical problems that frustrate serious photographers. The first problem is how to give your film the proper amount of exposure. It is very difficult to make a fine print from a negative that is seriously under- or overexposed. So-called "averaging" methods of exposure are unreliable, and bracketing cannot assure that you correctly exposed any given frame of your roll.

The Zone System teaches you a simple way of using any reflected light meter to achieve exactly the exposure you want every time.

The second problem is how to produce printable negatives from scenes that have either too much contrast or not enough. The processing instructions provided by film and chemistry manufacturers are not adequate for dealing with the variety of lighting situations facing photographers in the real world.

The Zone System solves this problem by teaching you how to control the contrast of your negatives by *systematically adjusting the amount of time you develop your film.* In essence, you will learn that film **exposure** and **development** are the only variables that you need to control to produce consistently printable negatives.

If all the Zone System did was to allow you to record a variety of photographic subjects consistently and accurately, that would be a real advantage to many photographers. On the other hand, we would all be transformed into sophisticated automatic cameras. In fact, through a key element of the Zone System known as *previsualization,* the Zone System functions as a powerful creative tool that allows photographers a remarkable degree of creative flexibility and control over the photographic process.

A good analogy can be made between the Zone System and music theory. Music is a logical organization of raw sound that allows coherent melodies to be created and recorded. The Zone System is a functional codification of the science of sensitometry (the study of the way light and photosensitive materials interact) into a simple and manageable working method. Just as a musician who can read music is able to play any annotated score, be it jazz or classical, the Zone System allows photographers to interpret what they see in any number of creative ways.

Q: Why is photographic technique so important?

A: Ideally, there is some feeling, concept, or idea that you are trying to express in your photographs. I think it is safe to say that the more effectively you are able to put your feelings on paper, the better your photographs will be. It is not possible to come up with a more precise definition of a "good photograph" because the range of creative possibilities is almost infinite.

And yet there is a relationship between the *structure* of your photographs (print quality, composition, etc.) and their *content.* In other words, your technique has a lot to do with how well your photographs get your message across.

The balance between structure and content in art is an important measure of mature work. Too much emphasis on one or the other will weaken the overall impact of your images. Sloppy or careless technique is distracting to the viewer, and yet overly structured photographs are often stiff and boring. The goal of a student should be to master the technical aspects of the medium so that he or she can easily give their work the structure it needs to be effective, without that effort impeding free expression. The Zone System is specifically designed to give photographers that freedom and control.

Q: If the Zone System is so important, how were good photographs taken without it?

A: By necessity, early photographers became masters of estimating light values and developing by inspection (see Appendix L). If there was any doubt about the exposure, they could always bracket just to be safe. Also, as will be discussed later, the photographic printing papers used by early photographers were extremely tolerant of mistakes in development. With the increase in the speed of modern papers, this is no longer true.

As you will soon learn, standardized methods of exposure and development simply are not reliable. Photographers need a way to adapt their techniques to suit the variety of problems they are likely to encounter. Many experienced photographers have developed personal working methods that are essentially derivatives of the Zone

System adapted to their style of shooting. The advantage of learning the system from the beginning is that it will save you a great deal of time, money, and frustration.

Q: Isn’t the Zone System useful only with view cameras?

A: No. With a view camera, each frame is exposed and developed individually. As you will see, this makes applying the Zone System to large-format photography very simple. On the other hand, the principles that govern the Zone System apply as much to roll film as they do to sheet film. Compromises are often necessary when using the Zone System with 35 mm cameras, but understanding the principles involved will give you all the control you need to get consistent results.

Q: Do I need a spot meter to use the Zone System?

A: No, although spot meters are generally more accurate than wide-angle meters, and they make choosing the correct exposure surprisingly easy.

Q: Camera manufacturers give the impression that taking good pictures can be simple and automatic. Is the Zone System outdated?

A: The suggestion that any given camera or meter can solve all your photographic problems is designed to inspire confidence and increase sales. Under average conditions, any good automatic camera can give you adequate results. Unfortunately, camera manufacturers cannot anticipate the variety of lighting problems that even a casual photographer routinely encounters. For this reason, automatic cameras, even when used properly, produce disappointing results much of the time. This explains the popularity of so-called “no-fault” picture-return policies. These promotions are fair, but they are little consolation if the ruined snapshot is your last and only portrait of your beloved Aunt Penny.

Also, as I mentioned earlier, it is impossible to design a camera that will adapt automatically to the departures from the norm that are so important to creative photography. The essence of art is learning how to break aesthetic rules in coherent and effective ways. To depart from average results, it is important to understand the nature of the problems you are likely to encounter. The Zone System will provide you with a working method that is flexible enough to deal with these problems and give you creative control over the medium.

Q: How does the Zone System apply to the use of an electronic flash?

A: The Zone System is primarily designed as an aid to previsualizing, measuring, and compensating for the unpredictable contrast of natural lighting situations. With typical on-camera electronic flash units you are providing a known quantity of light to your subject, essentially eliminating the need for routine exposure calculations and contrast measurement.

For a more detailed description on the use of electronic flash, see page 73.

Note: **With modern electronic flash units the exposure is determined by a thyristor circuit that controls the output of the flash head. Dedicated flash units automatically adjust both the f/stop and shutter speed of the camera.**

Q: Can the Zone System be used with color film?

A: The answer again is yes and no. Three interlocking elements make the Zone System work.

1. The Zone System enables photographers to visualize their subjects as finished photographic prints. Essentially, this means knowing what results you are working toward before you begin shooting. This is a valuable skill for all photographers to learn regardless of the kind of film they shoot.
2. The Zone System teaches you how to choose the correct exposure for any given shooting situation. This is especially important for color photographers because color-slide films are notoriously intolerant of under or overexposure. Color negatives will tolerate a small amount of overexposure but no underexposure.
3. Photographers using the Zone System learn how to measure the range of contrast of their subjects and then how to select the appropriate development time to produce printable negatives. Being able to measure subject contrast accurately is especially important for color photographers because color films (in particular color-slide films) are more limited in the range of contrast they can register than are black-and-white films.

Because color films must be developed within narrow predetermined limits of time, the ability to visualize, measure contrast, and choose accurate exposures is crucial for working with color materials.

For more information on color films and the Zone System see page 70.

Q: How does the Zone System apply to digital photography?

A: Correct exposure and contrast control is just as important to digital photographers as it is to those shooting film. The advantage of understanding the Zone System is that it provides a flexible and consistent method for visualizing and applying effective techniques to your work.

Chapter 10, The Zone System and Digital Photography, provides a detailed explanation for how to use the Zone System with digital cameras.

CHAPTER 2

Print Quality and Negative Contrast

Let's begin by defining a few important terms. Throughout this book you will find that the word **contrast** has different meanings depending on whether I am referring to the contrast of the *subject* you are photographing or the *negative* that you will use to make the print. In general, the word contrast refers to the relative difference between dark and light areas of the subject or negative.

> **Note: In the world of digital photography the term *dynamic range* is often used instead of contrast when referring to the difference between the darkest and lightest tonal values in an image.**

SUBJECT CONTRAST refers to the difference between the amounts of light reflected by the darker, or "shadow," areas of the scene and the lighter, or "highlight," areas (a dark door as opposed to a white wall, for example).

> **Note: In the Zone System, the words shadow and highlight are often used as general terms to describe any darker or lighter areas of the scene. Areas of the scene that reflect more or less light are also called "values." Thus a white wall is said to be a "highlight value," and a dark wall could be called a "shadow value." These terms will become more familiar as we go along.**

NEGATIVE CONTRAST refers to the relative difference between the more transparent areas of the negative and those that are more opaque. Because photographic negatives are actually coated with extremely thin layers of silver, they are said to have *shadow densities* and *highlight densities.** The shadow densities are more transparent and correspond to the darker parts of the print.

The highlight densities are more dense and appear as the lighter areas of the print. If any of this is unclear, refer to the section of the Primer called Photographic Emulsions before going on.

Subject Contrast and Photographic Papers

It is easy to visualize how dramatically the contrast of photographic subjects can vary from one situation to another. Imagine the difference between photographing a dark tree surrounded by

* These densities can be measured with an instrument called a densitometer.

brightly lit snow on one day and then shooting a portrait of a blond woman wearing a light dress on a beach when it's cloudy.

The relative contrast of a given scene depends on how light or dark the objects in the picture are and, on how much light is falling on them. Learning how to adapt your shooting and film-developing methods to suit a variety of different lighting situations is essential because modern photographic films and papers produce unsatisfactory results when the contrast of the scene is either too great or too flat.

It used to be that photographic papers were much more forgiving of negatives with excessive contrast. It's fascinating to look at old glass plate negatives and notice how amazingly dense and contrasty they could be. This is because legacy photographic papers were formulated with emulsions that were much less sensitive to light when compared to contemporary papers. It wasn't unusual for exposures to be many minutes under bright sunlight. This of course meant that the images couldn't be enlarged so the large plate negatives were instead contact printed in glass frames. The trade-off was that, in exchange for being slow, photographers were able to beautifully print negatives that had an amazingly wide range of contrasts.

Modern photographic papers are very different. To allow paper emulsions to record short exposures under the artificial lights of enlargers, contemporary papers can now only print negatives with a relatively narrow range of contrasts.

The Procrustean Bed of Modern Photographic Papers

In ancient Greece there was a myth about a diabolical innkeeper named Procrustes who offered passing strangers an invitation to spend the night on his special iron bed which he claimed would magically fit all who slept on it. What he didn't reveal is that to enforce his "one size fits all" policy, he would either stretch unsuspecting short visitors on a rack until they fit his bed, or cut off lengths of their legs if they happened to be too tall.

Historic photographic papers could generously accommodate a wide range of negative contrasts, but modern papers are distinctly "procrustean," because photographers now have to either expand or compress the contrast of their negatives so that they print well on the paper of their choice.

Every beginning photographer has experienced attempting to make a beautiful print from a negative that has more or less than average contrast. Typically you find yourself wasting many sheets of paper as you switch to higher contrast papers or filters to compensate for negatives that print too gray; or lower grades for negatives that are too contrasty. Either way the results are usually disappointing. Some photographers even assume that this is what paper grades are essentially designed for.

A better procedure would be to understand the tonal separation qualities of each grade of paper and choose one that best suits the aesthetic qualities of your work. For example, some photographers like the softer tonal gradations of low-contrast papers while others prefer the harder, more dramatic tonal transitions of higher contrast papers.

Ideally what you would do is choose a grade of paper that best suits your work and establish that as your standard. You may, for example, decide for aesthetic reasons that from now on grade or multicontrast filter #3 will be your normal grade of paper.

With this established your goal would be to learn how to make "perfect negatives," in other words, ones whose contrasts would allow you to easily print them on your grade 3 regardless of how contrasty or flat the original scene happened to be.

If the contrast of photographic subjects never changed, as in a studio where the lighting can be controlled, it would be easy to adopt a standard shooting and processing method that would give you good results every time. Because the contrast of scenes in the real world can differ greatly, it is necessary to learn first how to measure subject contrast and then how to compensate for it.

Working with Problem Negatives

Let's consider the four basic problems that photographers encounter when trying to make a good print from a negative that has been improperly exposed and developed.

As you will see, these four problems fall into two categories:

Overexposure and **Underdevelopment** are serious problems that are more or less correctable in the printing process.

Underexposure and **Overdevelopment,** on the other hand, are essentially fatal negative flaws that are uncorrectable. One great advantage of the Zone System is that it is specifically designed to help you avoid these two problems.

Underexposure

The simplest way to define a "good exposure" is to say that it means choosing a combination of f/stop and shutter speed that will allow the right amount of light to expose the film. It is important to understand that if the film receives **less** than this optimum amount of exposure, the negative will be **too thin** in the areas that correspond to the darker parts of the subject. What makes proper exposure so crucial is that the only time your film can record visual information in the darker shadow areas of your subject is during exposure.

FIGURE 1 An example of a print made from an underexposed negative.

Of course, underexposure will cause the entire negative to be less dense than normal, **but the lack of density in the shadow areas of the negative is critical.** When a negative receives too little exposure, it will be transparent in areas that you would ordinarily expect to print with full texture and detail (dark hair and fabric, for example). Because the necessary detail is not in the negative, these areas print as black, empty spaces.

Deliberate underexposure can often be used to create striking effects, but in general, these unnaturally dark areas are distracting and spoil the quality of your image. Of course, any dark area of a print can be made lighter by dodging when you make a print, **but no amount of careful printing can give a print detail that doesn't exist in the negative.**

As you will learn in the Chapter 10, underexposure is just as damaging to digital image files as it is to film.

For this reason, avoiding underexposure is essential. The rule is: **A negative has to receive at least enough exposure to ensure that the important darker areas of the print appear realistically well lit and detailed.**

Overexposure

Overexposure results in negatives that are too dense in the important shadow areas of the print. Prints made from negatives that are overexposed will be gray and lack richness and depth.

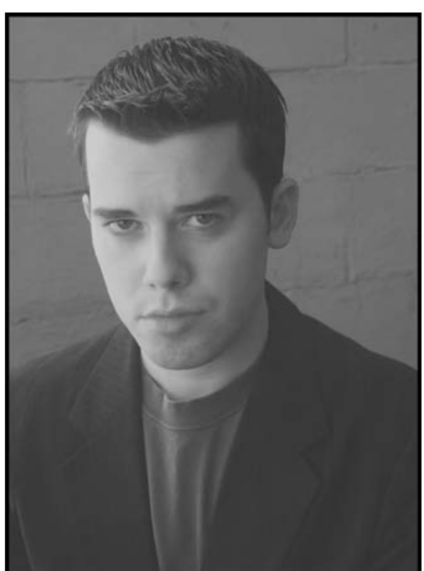


FIGURE 2 An example of a print made from an overexposed negative.

Overexposed negatives are often excessively grainy with shadow areas that are too light, but it's possible to correct for this to some extent by giving your print more exposure under the enlarger.

Underdevelopment

Film development has its main effect on the denser or **highlight areas** of the negative. An underdeveloped negative will be too thin in these areas and the resulting print generally will be too dark with no sense of light or brilliance.

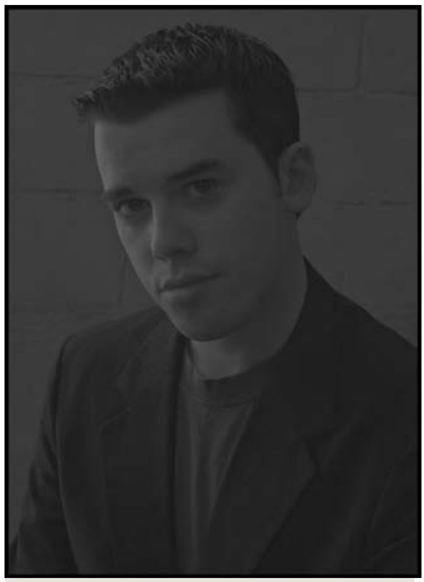


FIGURE 3 An example of a print made from an underdeveloped negative.

Underdeveloped negatives usually print flat on normal grades of paper, but using a higher than your normal grade can compensate for this to some extent.

Overdevelopment

If a negative is overdeveloped, either from being developed for too long or in a developing solution that was too concentrated or too hot, or from being agitated too aggressively, the highlight areas will be too dense.

Because these densities are relatively opaque, the corresponding light areas of the print will be too white or "blocked up." Burning in these areas when you make a print will make them darker, but it cannot replace the lost texture and detail.

Note: Although there are no films or developers in digital photography, blown out highlight areas are just as serious a problem. Unless you use certain limited techniques that are discussed in Chapter 10, there is no way to recover highlight detail that has been obliterated because of excessive contrast in your subject.

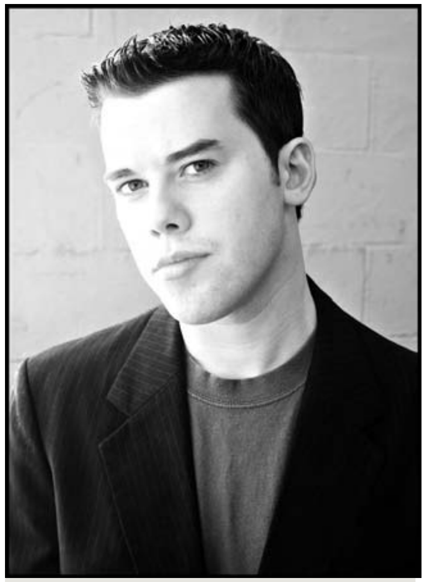


FIGURE 4 An example of a print made from an overdeveloped negative.

A print from a properly exposed and developed negative will have rich, detailed shadow areas and brilliant, textured whites.

FIGURE 5 An example of a print made from a properly exposed and developed negative.

Summary

1. After you have chosen your optimum, normal paper grade, learning how to control the contrast of your negatives is necessary because of the range of **subject contrasts** photographers have to cope with.
2. Until you learn how to adapt your methods of **exposure** and **development** to suit a variety of lighting situations, you will only produce easily printable negatives when the contrast of your subject happens to be average. Understanding this fact is the first key to becoming a better photographer.
3. **Exposure** has its primary effect on the **shadow densities** of the negative. Film **development** primarily affects the **highlight densities**.
4. Any combination of over- or underexposure or development will result in a negative that is either too dense or too thin.
5. The two "fatal flaws" of photography are underexposure and overdevelopment because these damage your negative quality in ways that cannot be compensated for when you make a print. Severe underexposure permanently obliterates necessary detail in the negative's shadow areas. Overdevelopment destroys detail in the highlight areas of the negative.

Trying to make a fine print from a negative with contrast problems can be a costly and frustrating ordeal. To a certain extent, graded or variable contrast papers can help, but **learning to control the contrast of the negative itself through proper exposure and development is the secret to consistently better results.**

Now that we have defined the problems, let's begin to approach the solution.

CHAPTER 3

The Control of Negative Contrast

There is a time-honored rule that summarizes the key to consistently better negative quality: **Expose for the shadows and develop for the highlights.** What this means is that exposure and development can each *independently* control a different aspect of the negative's contrast. Let's look at this process in detail.

Expose for the Shadows

Your choice of **exposure** for a given negative (the f/stop and shutter speed that you decide to use) should be based on the amount of detail you want in the darker areas of your finished print. If you want the shadow areas of your print to appear well lit and detailed, give the film *more* exposure; in other words, either use a wider aperture or a slower shutter speed. If you want the shadow areas to be darker and less detailed, give the film *less* exposure; use a smaller aperture or faster shutter speed.

As we discussed in Chapter 2, a mistake at this point can ruin your chances of ending up with a satisfactory image. **The rule is: exposure has its main effect on the density of the negative's** relatively transparent or **"shadow" areas.** Under- or overexposing can ruin an otherwise beautiful print. Once you release the shutter, the fate of the shadow densities is sealed!

Develop for the Highlights

The amount of time that you **develop** your film will determine the density of the negative's highlight areas and its overall contrast. Just as exposure has its main effect on the shadow areas of the negative, **the film's development time will determine how white or gray the lighter areas of the print will eventually be.** If you inadvertently over- or underdevelop your film, the highlight densities will be difficult or impossible to print well.

If exposure and development didn't act independently on the density of different parts of the negative, you would have no way of controlling its contrast. Knowing that exposure determines the shadow density and that development controls the highlights, you can use these two factors to your advantage.

Understanding this relationship makes it easy for a photographer with a trained eye to diagnose problem negatives. If parts of the negative that correspond to the darker areas of the subject are

too thin or transparent, the negative is obviously *underexposed*. If the highlight areas of the negative are opaque, the negative is *overdeveloped*. Before you go on, try the following exercise.

Underexposure

1. Gather an assortment of your problem and successful prints and their negatives.
2. Look carefully at those prints that are either too dark with empty, flat shadow areas or too gray with no black values at all.
3. On a light box (or through a window), compare the negatives from these prints with those from prints that have fully detailed, realistic shadow values. What you will see is that the shadow areas of the underexposed negatives are *more transparent* than the shadow areas of well-exposed negatives. More exposure would have solved the problem. You now know what an underexposed negative looks like.

Overdevelopment

4. Look at those prints that are too contrasty with empty, glaring white areas.
5. When you compare the negatives of these prints with negatives from prints that have detailed and textured highlight areas, you will see that the overdeveloped negatives are too dense or opaque.

Overexposed or underdeveloped negatives are slightly more difficult to read, but the principle is the same.

The reason exposure and development affect the film in different ways is a function of the way film responds to different amounts of development. Figure 6 illustrates how this works.

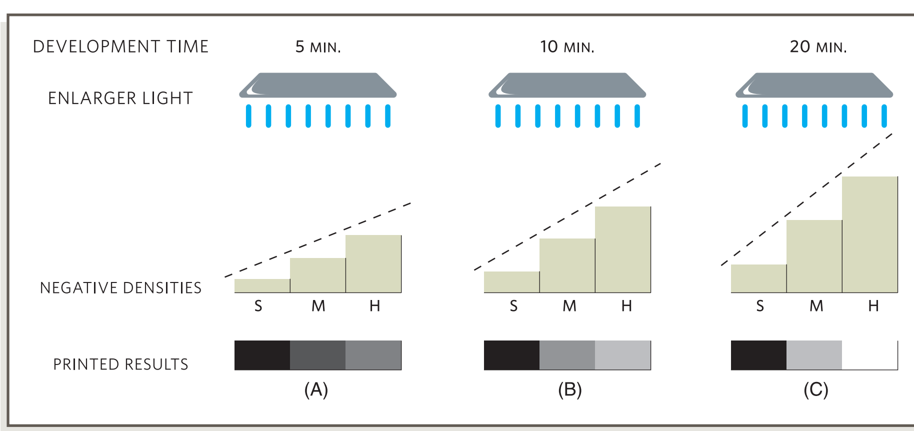


FIGURE 6 The effect of increased development on the shadow (S), middle (M), and highlight (H) densities of a negative.

Imagine that Figure 6A is a negative developed for five minutes and being viewed edge-on with greatly exaggerated shadow, middle, and highlight densities. The diagonal line illustrates the negative's contrast. The steeper the line, the more contrasty the negative.

Figure 6B is the same negative after being developed for ten minutes. Figure 6C is the same negative after twenty minutes of development.

Notice that after five minutes' worth of development, all of the densities have reached a given level, and the contrast is relatively flat. After ten minutes, the density of the middle and highlight areas has increased greatly, but the shadows have hardly moved at all.

Because the middle and highlight densities increase at a much faster rate as the negative continues to develop, the overall contrast of the negative becomes much greater.

After twenty minutes of development, the highlights are much denser, but again, because the shadows have remained relatively stable, the contrast of the negative is increased.

This difference in the rate of density increase between the shadow and the highlight areas is a very convenient effect. If the shadow densities increased at the same rate as the highlights, the negative would simply become more dense without any increase in its overall contrast.

The point to remember is that increasing or decreasing the negative's development time doesn't affect the shadow densities nearly as much as it affects the highlights. **This means that by varying the amount of time you develop the film, you can produce a usable negative regardless of how contrasty or flat the subject of your photograph may be.**

The general rules for controlling the contrast of negatives are as follows:

1. Your exposure should be based on the amount of detail you want to have in the darker areas of your finished print. Once the exposure is made, the shadow densities are established.

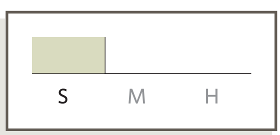


FIGURE 7 Shadow density is determined by exposure.

2. If the contrast of your subject is very flat, you can **simply increase the negative's development time to make the highlight densities more dense** and therefore the lighter areas of the resulting print whiter.

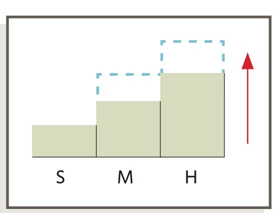


FIGURE 8 A longer development time increases the negative contrast of a flat subject.

3. If the subject is extremely contrasty (for example, dark foliage and bright snow in the same picture), you can compensate for this by giving the film less development.

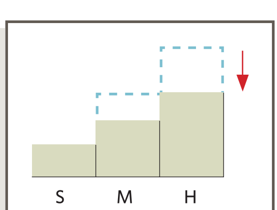


FIGURE 9 A shorter development time decreases the negative contrast of contrasty subject.

In short, **expose for the shadows and develop for the highlights.**

To understand some of the implications of this rule, study the following discussion of development very carefully.

Normal Development

For every combination of film and developer, there is a certain development time that will produce negative contrast that is **equal to the contrast of the scene that you are photographing.** This is called **Normal Development**, which is symbolized by the letter **N.** If, for example, eleven minutes is the Normal Development time for your favorite film and developer, that will be true as long as you continue to use that combination and don't change any of the other variables that affect development time. These variables are dilution, temperature, and the rate of agitation.

Since by definition, Normal Development means negative contrast will be **equal to subject contrast**, if the subject you are photographing has too much contrast, using Normal Development (eleven minutes in this example) will result in an equally contrasty negative! If the contrast of the subject is too low, Normal Development will give you a flat negative. If, on the other hand, the contrast of the subject is average, Normal Development will result in a printable negative.

> **Note: Paper grade 2, or variable contrast filter #2, is usually considered the standard for Normal contrast negatives. You can determine the exact time for Normal Development by testing your film, as outlined in Chapter 8.**

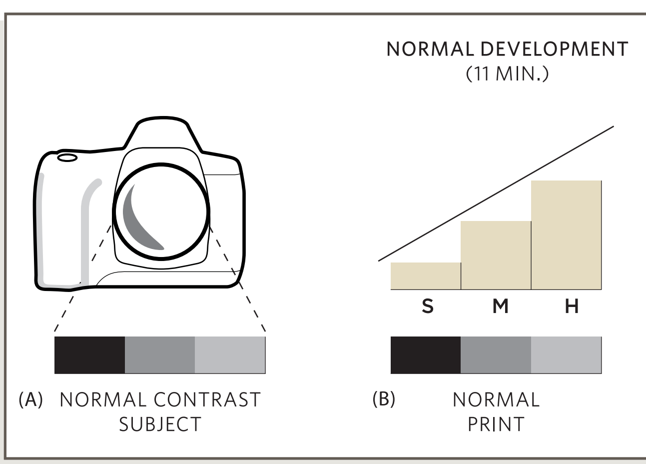


FIGURE 10 The effect of Normal Development on a subject with Normal contrast.

Figure 10A illustrates a negative being exposed to a subject with Normal contrast. Figure 10B shows that when the negative is given Normal Development, the resulting print will also have Normal contrast.

Normal Minus Development

If the contrast of the scene you are photographing is too great (if, for example, you are shooting in a dark room with a sunlit window in the picture), you can compensate for that problem in the following way.

First, as always, choose an exposure based on the amount of detail you want in the darker areas of the final print. **Expose for the shadows.**

Second, use a development time that is less than your established Normal Development Time to reduce the density of the negative's highlight areas.

Remember that increasing or decreasing the time that you develop your negatives will always have the greatest effect on the highlight densities. Because the shadow densities respond much less to reductions in the development time, only the middle and highlight densities of the negative will be significantly reduced. The resulting negative will have much less contrast than the original subject and thus will print as if the contrast of the subject had been within normal limits. This effect is called **Normal Minus Development**, or **Contraction.** The symbol for Normal Minus Development is **N−.**

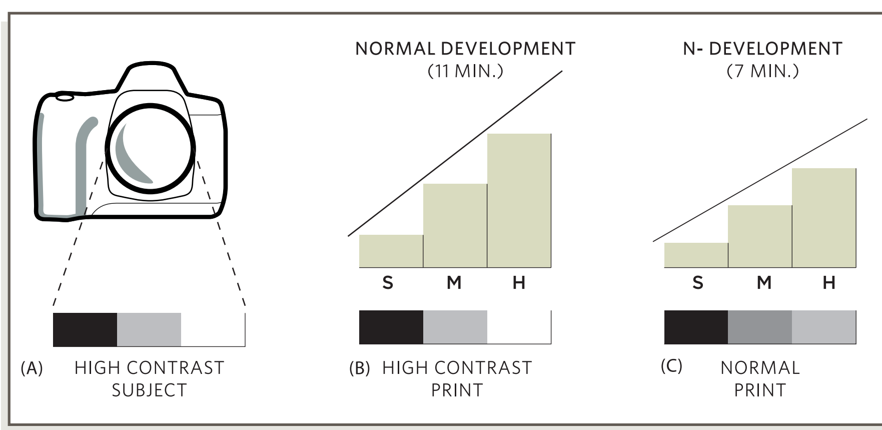


FIGURE 11 The effect of Normal and Normal Minus Development on an overly contrasted subject.

Figure 11A shows a negative being exposed to a very contrasty subject. Figure 11B illustrates that Normal Development results in a negative with overly dense highlights. Figure 11C shows that Normal Minus Development **reduces the density of the negative's highlight areas.** The result is a print with Normal contrast and detailed highlights.

Normal Plus Development

If the contrast of the subject you are photographing is *too flat* (for example, a dark interior or a cloudy day) you should still expose for the shadows, but in this case, you should also increase the development time (above Normal Development) to *increase* the density of the negative's highlights. This effect is called **Expansion**, or **Normal Plus Development**, symbolized by **N+.** The resulting negative will have much more contrast than the original subject and will print as if the contrast of the scene were greater than it actually was.

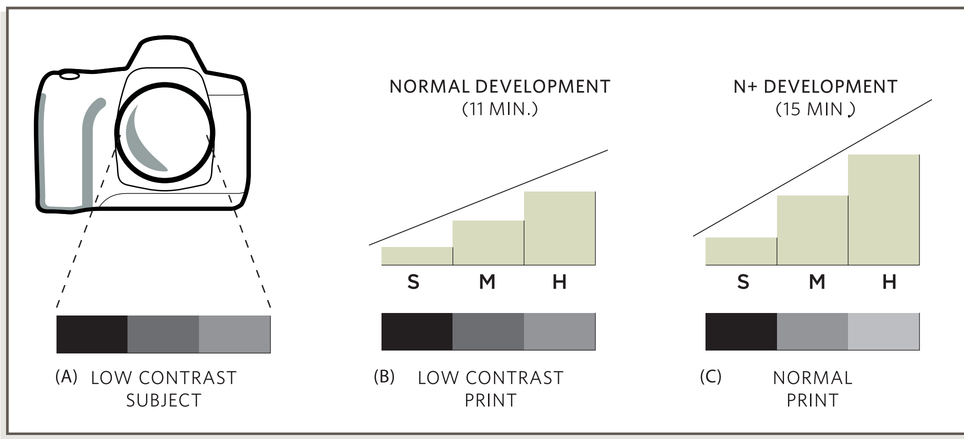


FIGURE 12 The effect of Normal and Normal Plus Development on a low-contrast subject.

Figure 12A shows a negative exposed to a very low contrast subject. Figure 12B illustrates that Normal Development results in a flat, low-contrast negative and print. Figure 12C shows that Normal Plus Development increases the density of the negative's highlight areas. The resulting print has Normal contrast.

Summary

In this chapter, we have learned two very important things about how to produce consistently printable negatives. First, the key to fine printing is controlling the contrast of the negative to compensate for variations in the contrast of the subjects you photograph.

Remember that **expose for the shadows and develop for the highlights** means choosing an exposure based on the amount of detail you want in the darker or shadow areas of your final print, then increasing your development time above Normal if the subject has less than Normal contrast or decreasing your development time (below Normal Development) if the contrast of the subject is too great.

Secondly, three general approaches to film development make this control possible.

1. **Normal Development (N)** is the standard development time for your favorite combination of film and developer that will always give you negative contrast **equal to the contrast of your subject**. Normal Development is the correct development time for subjects with average contrast and is determined by testing. See Chapter 8.
2. **Normal Minus Development (N−)**, or **Contraction**, is the reduction of your development time (below Normal Development) to compensate for subjects with contrast above Normal.
3. **Normal Plus Development (N+)**, or **Expansion**, is a longer than Normal Development Time to compensate for low-contrast subjects.

Thus far I have used the terms high, low, and Normal contrast very loosely. It is not difficult to visualize the difference in contrast between a bright, high-contrast situation and a flat, gray scene. To determine which of the above development procedures is appropriate, you need a way to actually measure the contrast of the scenes you wish to photograph. The visual concept that makes this possible is called the **Zone.**

CHAPTER 4

THE ZONE

The key element of the Zone System is a "visual ruler" that allows photographers to visualize and actually measure the difference between normal-, low-, and high-contrast subjects. This is called the **Zone Scale.**

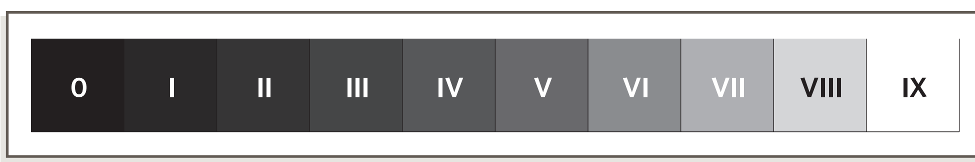


FIGURE 13 The Zone Scale.

Ideally, the tonal values in a photograph should logically represent the light and dark values we see in the world around us. When we photograph a dark wooden wall, for example, our expectation is that the resulting print will have the tonality and detail of dark wood. The visual unit that makes this correspondence between the real and the photographed world possible is called the **Zone.**

A Zone can be defined in three simple ways:

1. **Print Values.** Each zone symbolizes a different range of dark, gray, or light tones in a finished print. For example, Zone 0 is black, Zone V is middle gray, and Zone IX is white.
2. **Texture and Detail.** Every zone reveals a different amount of texture and detail. This allows zones to be associated with familiar objects that typically appear as certain zones. For example, in a normal black-and-white print, dark hair is usually Zone III, and snow can be printed as Zone VIII.
3. **Photographic Measurement.** Zones can easily be measured in terms of f/stops, shutter speeds, and meter numbers.

Print Values

The first definition of a zone is easy to understand if you look at the tonal values of a normal black-and-white print. In this case, the term "normal" refers to a print that is realistic and has a full range of tonal values from black to white. If you look closely, you will see that almost any photograph has within it the total range of possible print tones, from the blackest black that the paper can produce to the whitest white.

FIGURE 14 A full-scale normal print. (By David Bayles)

To begin the process of associating photographic print values with the Zone Scale, imagine the total range of tones in the above photograph spread out in a smooth gradation of values that gradually lightens from pure black at one end to pure white at the other.

FIGURE 15 Photographic print values as a continuous gradation.

Photographs printed from film negatives are analog and essentially contain an infinite number of shades of gray. (As you will learn in later chapters, digital prints are fundamentally different in this regard.)

You could, for example, divide the gradation in Figure 15 into any number of sections, and each one would be a little lighter than the one on its left. See Figure 16, for example.

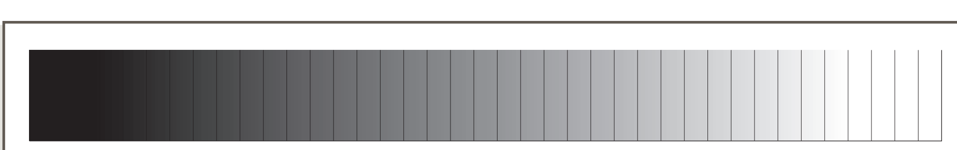


FIGURE 16 The print value gradation divided into numerous sections.

The Zone System divides this gradation into ten equal parts as shown in Figure 17. At one end is a section that is completely black and at the other end a section that is totally white. Keep in mind that all the tonal values in each section can be related to some part of the print in Figure 14.

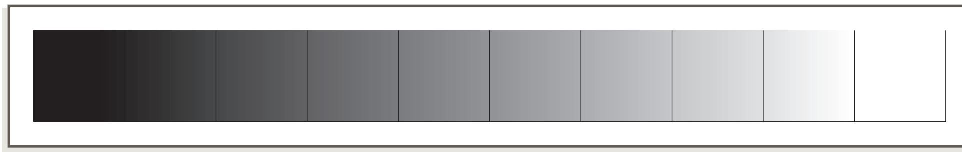


FIGURE 17 The print value gradation divided into ten equal sections.

At this point, the scale is still continuous, meaning that each section is actually a "mini-gradation" that is slightly darker at one end than it is at the other. (See Figure 18.)

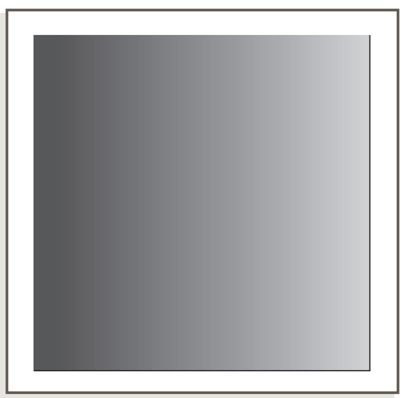


FIGURE 18 Zone as a mini-gradation.

To transform these sections into zones, we'll simply blend all the tonal values in each section into **one average tone that, from now on, will represent all the values in that section of the scale.**

As you will see this is an extremely important step in this process. The fact that each zone actually represents a mini-gradation of the slightly different tonal values greatly simplifies the process of identifying zones in the real world. Instead of having to visualize the specific value of each zone, you can instead look at a given object and safely assume that its tones will fall somewhere within the range of a given zone.

The scale is now divided into ten distinct steps, from black to white. If you assign a Roman numeral to each step, starting with 0 for the black section to IX for the white one, the steps are now officially **Zones**.

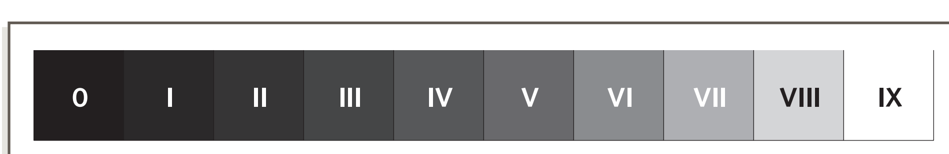


FIGURE 19 The Zone Scale.

The two key elements of this first definition of a Zone are

1. Each zone is one symbolic tone that represents the range of tonal values in its section of the Zone Scale.
2. Each zone can be related to the values in any photograph. The blackest black in a print would be Zone I, and the whitest white would be Zone IX. The clear film base of the negative is Zone 0.

By definition, the Zone Scale encompasses every possible tonal value in any photograph.

Of course, the tones in any photograph can be related directly to the values of the photographic subject. Identifying a wall *in a photograph* as Zone IV is another way of saying that the wall *itself* is visually Zone IV.

This line of reasoning leads to the second definition of a zone: zones as texture and detail.

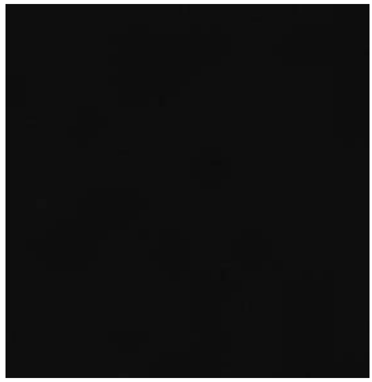
My goal is to make it possible for you to look at any photographic subject and say, "In the finished print, I want that tree to be Zone III and the sky to be Zone VI." If you were confident that this could be done consistently, photography would become as straightforward a process as a painter deciding that a tree on his or her canvas should be a given shade of brown. This is what the Zone System is designed to do.

Texture and Detail

To relate zones more closely to the real world, I will define each zone in terms of the way it should look in a normal print. As much as possible, I will refer to familiar objects that typically appear in photographs as certain zones. These descriptions will help you visualize zones for later use. Of course, you will not always want a given object to appear as a given zone. For example, in one portrait you may want brown hair to be Zone III and in another Zone IV. Keep in mind that offset reproductions can only approximate the tonality of real photographic prints.

The Zones

ZONE 0 is the easiest to define. It is the blackest black that the photographic paper can produce. Zone 0 has no texture or detail and appears as the most transparent areas of the negative. Because of the slight color added to the film base by the manufacturer to prevent halation and the chemical fog resulting from development, this density is sometimes referred to as "film base plus fog."



ZONE I is also completely without texture and detail. A glance around you will reveal many areas that should be printed as Zone I, including dark recesses or tiny cracks. In a normal print, Zone I would appear to be as black as Zone 0 until you put them side by side.

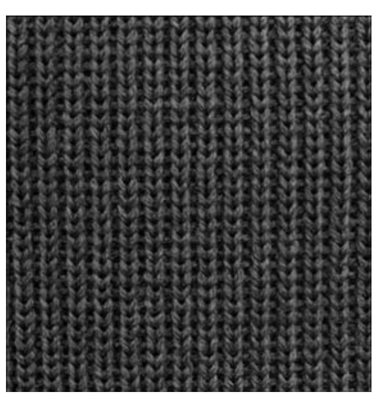
ZONE II is slightly textured black. This is the first zone in which you can begin to detect a trace of texture and detail. If your first impression of an object is that it's black, but you can still see the details of its surface you can safely assume that it should be Zone II in a normal photograph. Black cloth, black hair, or dark shadows are good examples of Zone II in the real world.

ZONE III is extremely important for many reasons as you will see later. The best way to distinguish between Zone II and Zone III is to remember that Zone II is black while Zone III is instead

dark gray **with texture and details that are easy to see**. Dark foliage, brown hair, and blue jeans are usually perfect Zone III subjects.

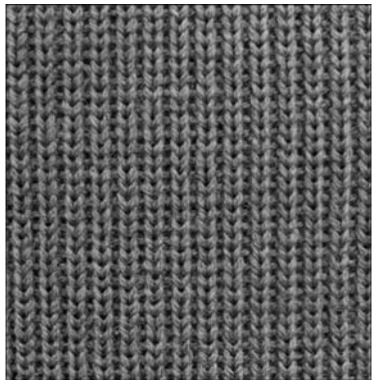
> **Note: A common mistake is to consider the darkest shadow you can find in the subject as Zone III. Actually, the darkest shadows in a scene obscure most of the detail in that area and should be rendered as a textured black value in the resulting print. Very dark shadows are generally Zone II. Remember that Zone III is the first dark zone that is fully textured. For this reason, we define Zone III as the zone for Important Shadow Areas (see Glossary).**

ZONE IV is best described as the average print value for dark-skinned subjects. Of course, a variety of complexions are common to dark-skinned people, but generally they fall within Zone IV. Shadows falling on a dark person's skin would be Zone III, and the lighter areas would be Zone V.

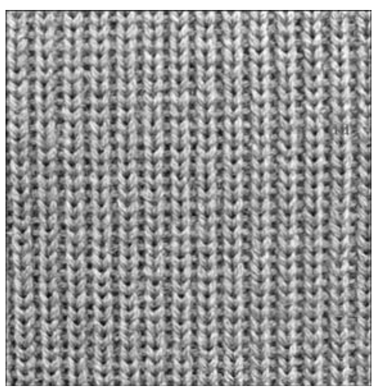


ZONE V is fully textured middle or "18 percent" gray. Like most things that are average, Zone V is difficult to describe. A dark blue sky will usually print as Zone V, as will stone in normal light or weathered wood.

As you will learn in the next chapter, Zone V is more important as a reference for determining the correct exposure than it is for visualization. In fact Kodak manufactures a Neutral Gray Card for use as an exposure guide that is precisely Zone V.

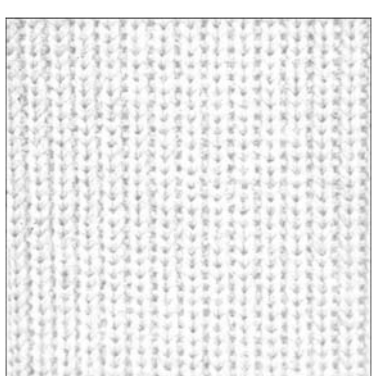


ZONE VI is fully textured and easy to describe because you can again relate it to skin tone. Caucasian skin that is not overly tanned usually prints as Zone VI. Shadowed white skin would be Zone V, and the highlights would be Zone VII.

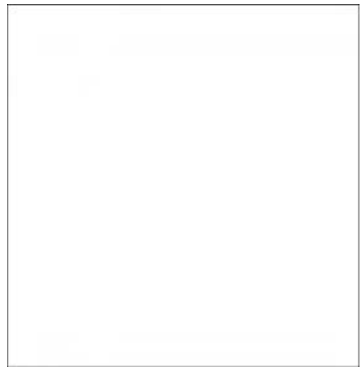


ZONE VII is light gray and fully textured. Sunlit concrete and light clothing are normally printed as Zone VII. Zone VII is textured as is Zone III, but on the light end of the scale. Just as Zone III is the first zone that is fully textured and detailed, Zone VII is the last. For this reason, Zone VII is defined as the proper zone for Important Highlight Areas. (See Glossary for a definition.)

Beyond Zone VII, the remaining zones become progressively less detailed.



ZONE VIII is textured white. Objects such as paper, snow, and painted white walls are often printed as Zone VIII.



ZONE IX is pure untextured white. This is the zone for specular reflections or light sources. The whitest white that the photographic paper can produce is Zone IX.

Our zones are now much closer to resembling the world as we see it, with various amounts of texture and detail in areas that are darker and lighter.

At this point, you should be looking around trying to see the various zones in subjects you may want to photograph. Begin by asking yourself questions such as "In a print, would that wall be Zone IV or Zone V?" It's easy to see how confusing this can be so, to simplify the process of seeing the real world in terms of zones, think of the Zone Scale as being divided into the three distinct sections illustrated in Figure 20.

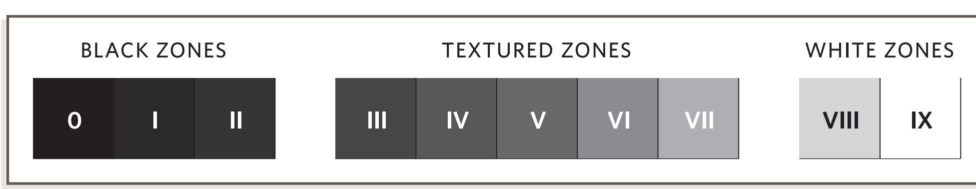


FIGURE 20 The Zone Scale's natural divisions.

Any well-lit or textured surface should fall somewhere in the **textured** range of zones. In fact, you will find that most areas of any normal print are made up of these five textured zones. If the object you are considering is dark and textured, you will want it to print as Zone III or Zone IV. If it is light and textured, such as concrete or light clothing, it must be either Zone VI or Zone VII.

This same line of reasoning can help you easily identify all the other zones. If an area of the subject is black, it will be Zone I or II, depending on the amount of detail that is visible. If the subject is white and slightly textured (snow or paper, for instance), it will realistically print as Zone VIII. Zone 0 is pure black, and Zone IX is pure white.

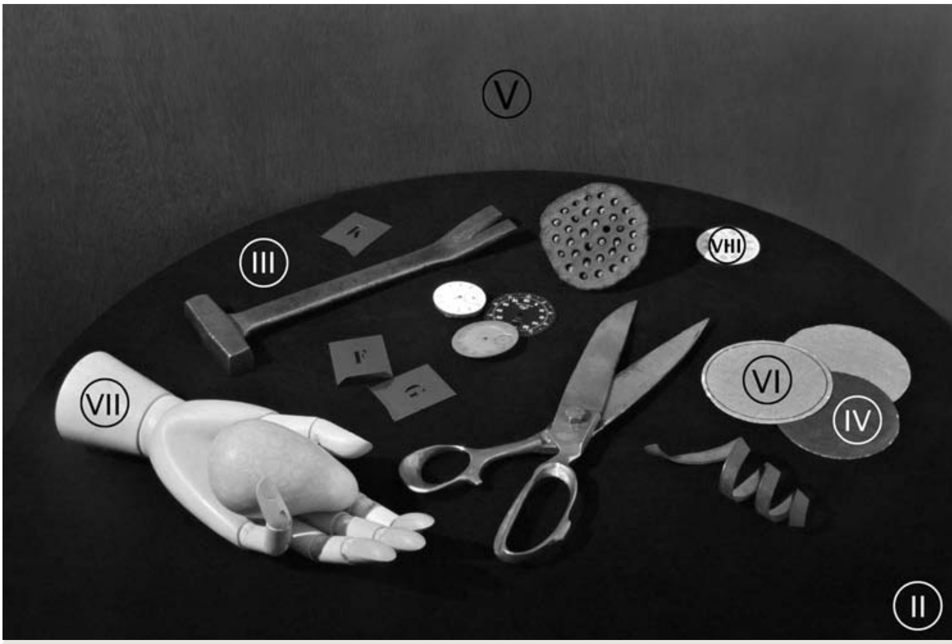


FIGURE 21 The zones of a normal print. (By Christine Alicino)

Previsualization

Experienced photographers make a number of technical and aesthetic decisions before taking a given photograph. First of course there are the general considerations like deciding whether the photograph should be in color or black and white, a close-up or a long shot, or vertical or horizontal.

What the Zone System does is extend this *before-shooting* decision-making process to include previsualizing the actual tonalities of the final print. This means looking at your subject and *mentally picturing* the way you want it to appear in the photograph that you are eventually going to make. For example, if you are photographing a model with brown hair, you will most likely want her hair in the finished print to be dark with all of its texture showing clearly. In other words, you want it to print in Zone III, or perhaps Zone IV if her hair is light brown.

Deciding beforehand that you would like her hair to be no darker than Zone III is important, because if you inadvertently underexpose the film and her hair turns out to be Zone 0, you will be very disappointed.

Very often your intention will be to record the subject just as you see it. On the other hand, the range of creative possibilities is limited only by your imagination ; and imaginative seeing is exactly what previsualization is all about!. Whatever approach you decide to take, either recording your subject as is or interpreting it creatively, previsualizing the print before taking the picture is a very important skill to learn. The better you are able to previsualize the image that you are trying to make, the easier it will be for you to get the results you want.

Previsualization Examples: Dramatic and Subtle

The Zone System gives you the freedom to previsualize your subject in a variety of creative ways. You may, for example, want to create abstract images by greatly increasing or decreasing the subject's contrast. Figure 22A is an example of how an ordinary beach scene can be dramatically transformed by previsualizing it as a curving white pattern of foam against black sand and water. This image is the result of greatly underexposing and then overdeveloping the negative.

FIGURE 22A Beach scene previsualized as a high-contrast abstraction.

You will find, however, that even subtle alterations in the print's tonality or contrast can make an important difference in the overall impact of your image. You could, for example, decide to previsualize the background of your image as darker than it actually was, but still fully detailed. Using Zone System terminology you would say that the background should be Zone III instead of Zone V.

The example in Figure 22B illustrates the difference this simple creative previsualization can make.

FIGURE 22B Two previsualizations of the same portrait.

Both of the pictures in Figure 22B were photographed under the same lighting conditions and were printed on the same grade of paper. Figure 22B *left* is a normal view of the portrait. The tone of the wooden wall is approximately Zone V. Figure 22B *right* was produced by Placing* the wall on Zone III and then expanding the contrast of the negative by increasing its development time.

The darker background and increased contrast of Figure 22B *right* draw your attention to the model's face, creating a more striking portrait. Many photographs could be vastly improved by a little forethought. And remember, these examples were done with exposure and development modifications, not through printing techniques.

With practice, you will find that previsualizing is not only simple to learn, but it also offers you a great deal of creative freedom. The important thing to remember is that *the way you previsualize your photograph will ultimately determine the way you will expose and develop your negatives.* The techniques for doing this are described in Chapters 5 and 6.

The following is an interesting exercise I recommend for photographers who are approaching the concept of previsualization for the first time.

Select a number of your favorite photographs from books, magazines, or your own collection and try to imagine how the actual subject may have looked if you had been at the scene where these famous photographs were actually taken. Is the image completely "natural-looking"?

Most likely what you will discover is that even so-called "documentary" photographs are actually tonal abstractions that gain dramatic impact or subtle beauty by being somewhat more contrasty or softer than you would expect from natural lighting conditions. The works of Bill Brandt, W. Eugene Smith, Brett Weston, Minor White, Wynn Bullock, or Paul Caponigro are all good examples of this. An exercise of this kind will teach you a great deal about the amount of creative control inherent in the art of photography.

*See Placement in the glossary.

Measuring Zones

The first two definitions of the zone link photographic prints to the visual world. For example, you could now say, "I want that person's face to print as Zone IV." The third definition of the zone establishes the same kind of relationship between zones and the tools of our trade, the *camera* and the *light meter*.

> **Note: For the time being I will limit my discussion to the uses of hand-held light meters because in some ways, these are the most functional for use with the Zone System. A detailed explanation of the application of the Zone System with built-in camera meters appears in the next chapter.**

At this point, the important question is: How do zones relate to f/stops, shutter speeds, ASA numbers, and the numbers that light meters use to measure brightness?

The answer is that all these controls measure equal amounts of light. **F/stops, shutter speeds, meter numbers, ASA numbers, and zones all measure light according to a ratio of 2 to 1.** This means that whenever you see two of these numbers side by side, one represents *twice* as much light as the other. For example, f/8 exposes the film to *twice* as much light as does f/11 and *one-half* as much as f/5.6.

> **Note: Keep in mind that for these examples I'm referring to the classic whole f/stops and shutter speeds rather than the incremental numbers that appear between them on some meters.**

Another way of saying this is that f/stops, shutter speeds, ASA numbers, and meter numbers all measure amounts of light that *double* going in one direction and *halve* going in the other. The ratio of light measurement between all whole photographic settings is 2 to 1.

Zones follow the same rule: Zone V represents *twice* the amount of light as Zone IV, *one-half* as much as Zone VI, and so on up and down the scale. This may sound complicated at first, but take a careful look at the chart in Figure 23.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
1. UNITS OF LIGHT	½	1	2	4	8	16	32	64	128	256
2. EXPOSURE VALUES (EV)	0	1	2	3	4	5	6	7	8	9
3. RELATIVE f/STOPS	F/64	F/45	F/32	F/22	F/16	F/11	F/8	F/5.6	F/4	F/2.8
4. RELATIVE SHUTTER SPEEDS	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec.	2 sec.
5. RELATIVE ASA	6400	3200	1600	800	400	200	100	50	25	12

FIGURE 23 The equivalence of zones, meter readings, f/stops, shutter speeds, and ASA numbers.

Line 1 is labeled "Units of Light." Notice that Zone I is directly over 1 unit, Zone II over 2 units, and so forth. This indicates that if Zone I were said to equal 1 unit of light, Zone II would equal 2 units, Zone III would equal 4 units, Zone IV would equal 8 units, and so on. Their progression is *geometric*, meaning that each number *doubles* as it progresses upward.

In other words, the actual amounts of light the zones represent *doubles* as the zones get *lighter* and *halves* as the zones get *darker.* This is what is meant by a ratio of 2 to 1. Make sure that this is clear before reading on.

Line 2 shows that although the numbers that you see on the dials of certain hand-held meters progress arithmetically (1, 2, 3, 4, 5, etc.), they also represent amounts of light that increase geometrically. If meter number 1 equals 1 unit of light, meter number 2 will equal 2 units, meter number 3 will equal 4 units, and so on. This means that if you aim your meter at one wall and it reads number 6, and then you aim it at another wall and it reads number 7, the second wall is reflecting *twice* the amount of light when compared with the brightness of the first. Meters are designed this way because the manufacturer wants to avoid putting large numbers on the dial. Following the above analogy, meter number 11 would equal 1,024 units of light. Meter numbers of this kind are called EV numbers or "Exposure Values."

> **Note: EVs are standard from one meter to the next, but some light meters use numbering systems that are arbitrary because an amount of light that might read number 10 on my meter could read as number 8 on yours. The same amount of light is being measured but the numbers are different because the light meters were made by different companies.**

Lines 3 and **4** show that f/stops and shutter speeds are also calibrated according to a ratio of 2 to 1. The numbers themselves don't always double, but the amounts of light that they measure do.

> **Note: F/stops and shutter speeds are labeled as "relative" because this chart intends to show how these numbers relate to each other; in other words, that they all measure equal amounts of light. Do not read this chart as indicating that f/11 @ 1/8 will always give you Zone V. Your actual exposures will depend on the amount of light in your scene.**

Line 5 illustrates that ASA numbers are also calibrated according to this ratio. If one film is rated **ASA 200** and another **ASA 400,** the second film is **twice** as sensitive as the first. In other words, it takes **one stop more exposure,** or two times the amount of light, for the first film to give the same results as the second. The rule to remember is: Using **half** the ASA number (ASA 400 to ASA 200) is the same as **doubling** the exposure; **doubling** the ASA cuts the exposure in **half** or, in other words, reduces it by **one stop.**

The fact that zones fit neatly onto this chart has far-reaching implications. Think through the following example very carefully.

Suppose you are photographing a scene with two walls and you wanted to know how much darker one wall was than the other. For the sake of this example, let's say that the meter reading you got for the light wall was 1/60 @ f/11 and for the dark wall it was 1/60 @ f/8. Later we will be discussing the logic behind why the meter is recommending more exposure for the dark wall and less for the light wall, but for now it's enough to understand that you could either say that there is a one f/stop difference in brightness between these two walls, or a one-**zone** difference. For the purposes of contrast measurement the two terms are interchangeable!

By remembering that each meter full f/stop or shutter speed equals one zone, you can measure the contrast of any scene in terms of zones.

If instead of using f/stops and shutter speeds you were to use EV numbers to measure the contrast of your subject, you might discover that the lowest meter reading you can find in a

given scene is EV number 3. If the highest reading is EV number 10, you could describe this scene as having eight stops' worth of contrast, or eight zones' worth of contrast.

As an exercise, try measuring the range of contrast in a variety of situations in terms of zones. Gradually, the equivalence of zones, meter numbers, f/stops, and shutter speeds will become clear.

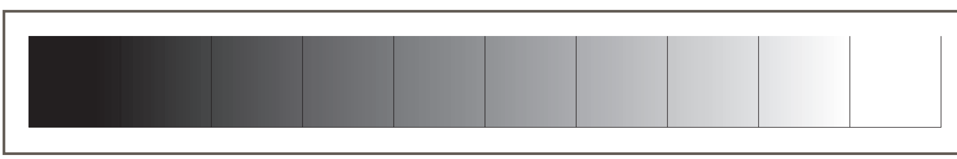
Summary

Let's briefly review what you have learned about zones in this chapter.

Zones and the Print

Starting with a continuous gradation consisting of all the possible tones in a print from black to white, zones are formed by following this procedure:

1. Divide the spectrum into ten equal sections.

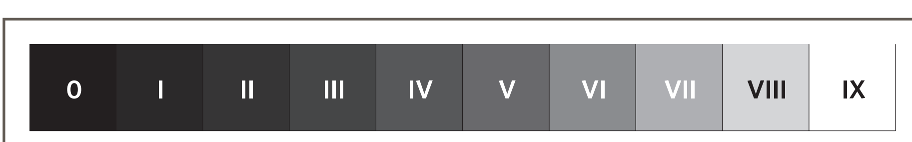


Ten-step divided gradation.

2. Blend each section into one tone that represents all the tonal values in that section.

Ten symbolic tones.

3. Number each section with Roman numerals from 0 for the black section to IX for the white one.



The Zone Scale.

Texture and Detail

1. In a fine print, each zone has a different amount of texture and detail. There are three types of zones:
    a. Zones that have no texture and detail that are used to represent extremely dark or pure white objects in a photograph (Zones 0, I, and IX);
    b. Zones that have a limited amount of texture and detail that are used to represent very dark or light objects that are slightly textured (Zones II and VIII); and
    c. Zones with full texture and detail that make up the greater part of most photographs (Zones III, IV, V, VI, and VII).
2. Zones help us to mentally picture the subject being photographed in terms of the final print that we hope to make. This is called previsualization. Remembering how zones look in terms of subject matter makes previsualization relatively easy.

Measuring Zones

Zones represent amounts of light that double as the zones become lighter and halve as they get darker. In this sense, zones are equivalent to all other photographic controls. One zone equals one whole f/stop or shutter speed, one EV meter number, and ASA numbers as they double and halve. This equivalency allows you to measure the contrast of any scene with f/stops, meter numbers, or zones. For the purposes of the Zone System they are all the same.

CHAPTER 5

EXPOSURE

To understand how Zone System theory applies to exposure, let's first consider the different types of light meters that are available and how they function.

Light meters come in two general types: meters that measure what is called incident light, and meters that measure reflected light.

Incident-light meters measure the light that falls on the subject from the source of light (Figure 24). Incident-light meters are especially useful in lighting studios or on movie sets where the contrast can be controlled with fill-lights or reflectors. Under those conditions, your primary concern is to make sure that the amount of incident light falling on your subject does not change from one shot to another.

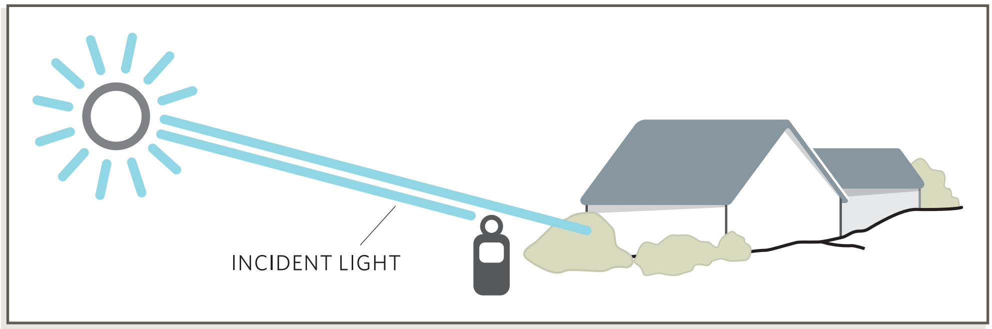


FIGURE 24 Incident-light reading.

Reflected-light meters measure the light that bounces off the subject to the camera and film (Figure 25).

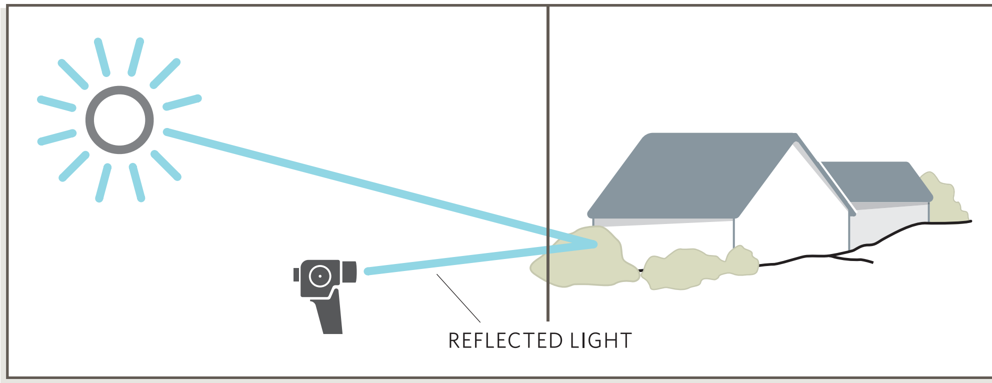


FIGURE 25 Reflected-light reading.

As we discussed earlier, with the Zone System, we are primarily interested in measuring the contrast of a given scene. The question is: How much light is coming from one area as opposed to another? Only a meter that measures reflected light can effectively tell us this difference.

There are three different types of reflected-light meters: spot meters, wide-angle meters, and built-in camera meters.

The first two types of reflected meters differ in terms of what is called their angle of incidence. A wide-angle meter “sees” at an angle of approximately 30 degrees, while a spot meter reads at an angle of only 1 degree or less in some cases (Figure 26).

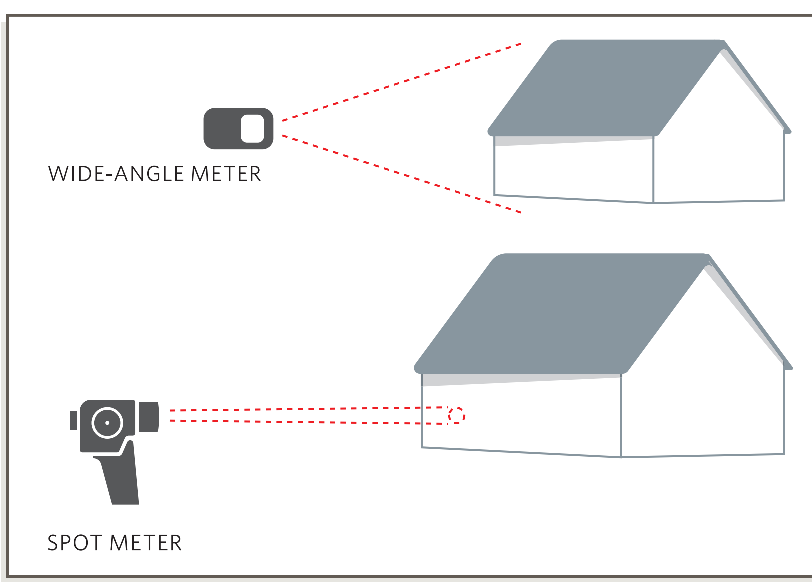


FIGURE 26 Wide-angle and spot meters.

This is similar to the difference between looking through a straw as opposed to looking through a cone. The advantage of using a spot meter is that it allows you to measure the light from small, isolated areas very accurately at a distance. Imagine that you need to know how much light is reflected by a model's face. With a wide-angle meter, you would have to get very close to avoid including her hair in the reading. This is less of a problem if you can approach the subject, but if you are photographing distant mountains or performers on a stage, a wide-angle meter can make getting an accurate reflected reading very difficult, if not impossible.

The acceptance angle of a built-in meter varies depending on the kind of meter the camera uses and the focal length of your lens.

Thus far, I have talked about "exposing for the shadows," or "making the background Zone III," without explaining how this is actually done.

The problem of how to calculate the proper exposure becomes easy when you understand more about what a light meter is actually designed to do.

Light meters are programmed to perform two different but related functions: Light Measurement and Exposure Recommendation.

Light Measurement

The first responsibility of any light meter is to simply measure the quantity of light reflected by the subject. Many light meters measure light using Exposure Values or EV numbers. As you saw in Figure 23, EV numbers provide a very simple and intuitive way to measure amounts of light: the lighter the surface measured, the higher the number.

We also learned that because EV numbers and zones both measure amounts of light that double as they increase, you can use one to represent the other. If one surface reads EV #7 and another EV #8, you could either say that they are one EV number apart or one zone apart.

> **Note: Because of the conceptual simplicity of this method, many of the examples that follow will use EV numbers to illustrate various principles being explained.**

In Figure 27, the meter is telling us that the wall being read is reflecting 15 units of light. Remember that unless these are EV numbers they are arbitrary. On another meter, the same amount of light might be number 11.

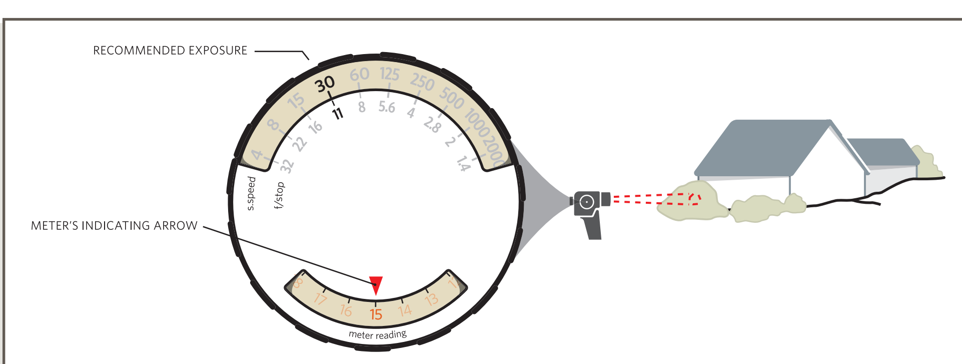


FIGURE 27 Meter reading.

When in-camera light meters are in their manual mode they measure quantities of light through some sort of "nulling" system. For example, bright light may cause a needle or a red dot to move up and you may need to turn an aperture or shutter speed dial until you see that the dot is in the center of a scale, or perhaps a needle is lined up with a ring.

Whichever system the meter uses, all it is doing is indicating that either more or less light is reflected by whatever is in the meter's field of view.

Exposure Recommendations

The second thing a light meter does is to convert its light reading into an exposure that you will use to take the picture. It's as if the meter were saying "I can see that the wall is light gray (the measurement) so I'm recommending that you use this combination of aperture and shutter speed (the exposure) to make it look that way in your print."

Analog hand-held light meters have an indicating arrow or pointer that is used to line up opposite the indicated meter number. When this is done, the meter's dial matches an f/stop with a shutter speed for the "correct" exposure.

Note: Digital light meters often have an LCD screen that simply displays its recommended exposure.

In Figure 27 the meter's indicated exposure is f/11 at 1/30 of a second.

As I mentioned above, in-camera meters combine these two functions because to center the meter's light measuring symbol, you have to match an aperture with a shutter speed and these are the meter's recommended exposure.

The Meter's Dilemma

Unfortunately, finding the correct exposure isn't always that simple. The problem is that light meters have no way of actually "seeing" the objects they measure. An exposure meter is simply a device that measures quantities of light and the problem is that both a light surface and a dark surface will reflect the same amount of light if the light falling on them is changed. On a bright, sunny day a dark wall might read meter number 11, but so might a light wall on a cloudy day! To your eye, the light and dark walls are obviously very different, but to the meter, they are both meter number 11.

Think about this for a minute. "Seeing" is a complex process of visual perception that is much more than simply measuring amounts of light. For example, a piece of white paper looks white to you in both a bright light and a dimly lit room.

The light meter is responding to the change in the incident light, but you can judge that the dark wall should print as Zone III and the light wall as Zone VII.

Unfortunately, the meter still has the responsibility of suggesting the correct exposure for you to use. In this example, given that the meter reads both walls as number 11, it obviously cannot suggest the different exposures that the two walls would require. Light meters are designed to get around this problem in a simple way: They lie! Because the meter can't tell that the dark

wall is dark or that the light wall is light, it will simply pretend that both walls are ***middle gray***. In this way, the exposure that it recommends can at worst only be half-wrong. Of course, if the wall had been gray in the first place, the meter's recommended exposure would have been perfect.

The fact is that all light meters are programmed to give you an average gray exposure for whatever amount of light they are measuring.*

In the language of the Zone System, we would say that all light meters will automatically place any light reading on Zone V. This is very important for you to understand and remember.

This principle explains why the exposures I used in the previous chapter changed the way they did. Remember that I said that the meter reading for the white wall was 1/60 @ f/22 and for the black wall it was 1/60 @ f/5.6. In both cases the meter is suggesting an exposure that will make each wall print as middle gray. To make a black wall gray the meter has to recommend an exposure that makes it lighter. (Gray is lighter than black.) Conversely, to make a white wall gray it needs to recommend an exposure that makes it darker. (Middle gray is darker than white.)

A simple demonstration that you can do with your own camera and film or with Polaroid materials will illustrate how this works.

> **Note: I strongly recommend that any reader approaching the Zone System for the first time should stop and work this demonstration through to the end before going on. Not only will it graphically illustrate the way light meters operate, but it will also function as an ideal warm-up for Zone System testing.**

Before you begin, it is a good idea to have your light meter and shutter speeds tested for accuracy and consistency. If your technician advises you that your equipment tests within reasonable limits, proceed with this demonstration. If not, leave the equipment with the technician to be adjusted.

Exercise: How Light Meters Really Work

To do this demonstration, all you need are four frames on any roll of film, two walls (a light one and a dark one), and a reflected light meter. A "Zone V" Neutral Gray Card from Kodak will be useful when you make a contact print of these test exposures.

Readers with digital cameras can also do this exercise using their preview window to see the results.

In choosing your test subjects, try to select walls that match your mental image of Zone IV for the dark wall and Zone VI for the light wall. This will be your first exercise in previsualization. It is very important that you find evenly textured surfaces and that you fill the frame of your camera with only those areas before you shoot. Be careful not to include your shadow in the image.

If your camera is equipped with an automatic built-in meter, you will either have to set it to its "manual" setting or override the automatic function; otherwise when you stop down one stop, the meter will automatically change the shutter speed to one step slower in order to maintain its Zone V exposure. Check your owner's manual if you are not clear on how this is done with your camera. See page 74 for a discussion of how to override automatic built-in light meters.

* Some exceptions to this rule will be discussed later.

Exposure Plan

Frame 1: Take a careful meter reading of the dark wall and make an exposure of only that surface using the meter's recommended f/stop and shutter speed. With built-in meters, center the dot or arrow of the meter and shoot.

Frame 2: Make an exposure of the same dark wall using an exposure that is one stop less than the first. Do this by either stopping down one f/stop from the first exposure or using one shutter speed faster. I will explain the purpose of this adjustment later in this chapter. The goal of this step of the exercise is to underexpose the film by one stop (Zone IV) when compared to the exposure used for frame 1.

Frame 3: Carefully meter and shoot the light wall using the meter's recommended exposure.

> **Note:** Be sure to take your light reading at the same angle you intend to shoot the picture and that you use the correct ASA for the film you are using. If your camera has a compensation control dial, be sure to set it at zero.

Frame 4: Photograph the light wall using an exposure that is one stop more than the meter's recommended exposure. For frame 4 you will be overexposing the film by one stop (Zone VI) when compared to frame 3.

Frame 5: Put the lens cap on your lens and shoot one blank frame.

Process this roll of film using your standard development time and make a contact print of your five test frames. Choose an exposure time for this contact print that is the minimum amount of exposure under the enlarger that it takes to make your blank frame (frame 5) as black as it will get. To find this time, make a series of test exposures at two-second intervals across frame 5. The first exposure step that turns this unexposed frame as black as the paper will get represents your minimum time for maximum black. For a detailed explanation of this procedure see Chapter 8.

Your four other test frames should something look like this:

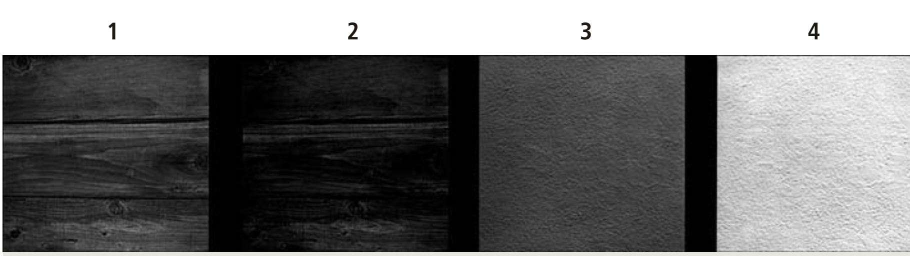


FIGURE 28 Zone placement test frames.

Notice that frames 1 and 3 are very similar in tone (they should approximately match your Neutral Gray Card). This is because the meter is blindly trying to give you the "correct" exposure by averaging the dark and light values of the walls to middle gray (Zone V).

Frames 2 and 4 should be much closer to the actual tonal values of the original walls.

> **Note: A valuable extension of this demonstration would be to expose two rolls of film in exactly the same way using the procedure described above. Develop the first roll using your standard development time and the other at a time that is 20 percent longer. Contact both rolls at times that allow the first and third frames to match your Neutral Gray Card. What you will notice is that while the frame 2s on both rolls are very similar in tone, the frame 4s are noticeably different: The frame 4 (in Figure 28) that has been developed for 20 percent longer is noticeably lighter. This illustrates the effect of increased development on the highlight values, as described in Chapter 3.**

Exposure Placement Demonstration with Polaroid Films

The advantage of doing this demonstration with your own materials is that it will give you an opportunity to test your ability to solve a simple exposure problem. On the other hand, the fastest way to see the result of this process is to work with any color Polaroid camera.

With any Polaroid color camera, photograph a dark and a light wall. It is important that you fill the frame with each wall so that none of the surrounding area is included in the image. Also, to obscure any surface detail, do not focus the camera, if this is possible. When both pictures are developed, you will see that they bear little resemblance to the two walls. In fact, if you have done this correctly, the two pictures should be very similar in tone. Any difference between the two images will be the result of the different response that the color film has to different colors and to the compensation that the meter makes to very high or low light values. The point is that the two pictures will be much closer in value to each other than they are to the walls themselves.

The Results

What this demonstration shows is that the camera's built-in meter is programmed to render any single subject value as an average middle gray tone, or Zone V, regardless of how dark or light it may actually be. With a few exceptions I will discuss later, all light meters are designed the same way.

What you should have learned from this demonstration is that if you were always to follow the meter's recommendations, it would be a classic case of the blind leading the blind: You see the wall as a dark value, the meter sees it as gray, and the meter's choice prevails. To consistently achieve the correct exposure for any subject, you need a way to tell the light meter how you want the walls to print. When you apply all that you have learned thus far, the method for doing this will seem very simple.

To demonstrate the Zone System method of exposure, imagine that Figure 29A is an actual subject that you are trying to photograph.

FIGURE 29A Normal print.

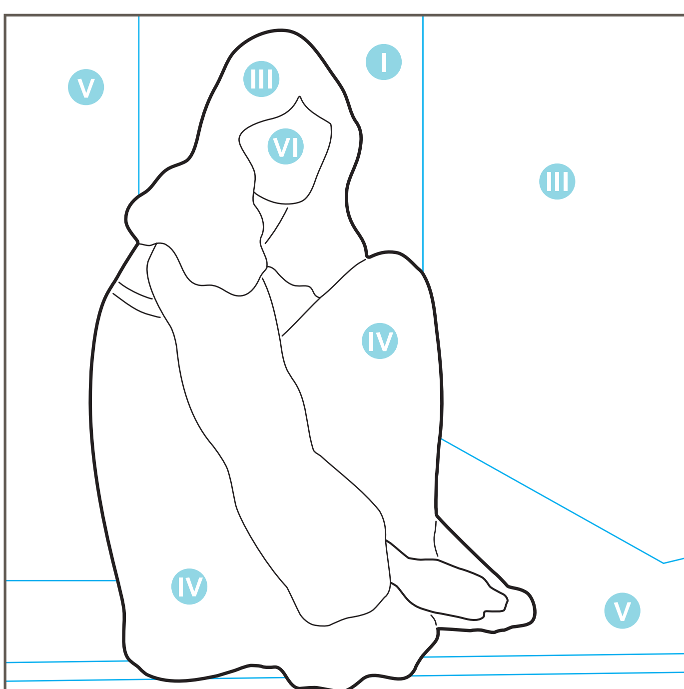


FIGURE 29B Zone placements of Figure 29A.

Exposure Detailed

The first step in the process of correctly exposing any photograph is previsualization. In terms of deciding how to expose a given subject, the important question in most cases will be, what part of this picture do I want to print as Zone III? Zone III is important because it is the darkest zone that shows full texture and detail. Remember that the rule is: **Expose for the Shadows**. Take a careful look at Figure 29A. Imagining that this is an actual scene, which areas would you judge to be Zone III? The obvious answers are the model's hair and the darker parts of the door on the right. For brown hair to print realistically it has to be detailed enough to show individual strands. This automatically indicates Zone III. Blond hair is closer to Zone VII.

Place and Fall

The concept of zone "placement" is extremely important in Zone System theory because it describes the process that will ultimately determine your exposure. In any photographic subject, you will always find some dark area that in your opinion absolutely needs adequate texture and detail. This part of your image is called the Important Shadow Area. After you have identified the Important Shadow Area, your goal in most cases will be to choose an exposure that will render that area as Zone III in the finished print. This is called "Placing the Important Shadow on Zone III" (see Figure 29B). Remember that Zone III is the first dark zone that has full texture and detail. Also remember that Zone III is not black.

When you decide to place a particular area of the subject on Zone III, you are saying in effect that you will not mind if any inherently darker area of the scene is black or nearly black in the finished print. Another way of putting this would be to say that after the Important Shadow has been placed on Zone III, darker areas of the subject will fall on Zones 0, I, or II. The dark interior behind the model's head in Figure 29A is a good example of an area that should logically fall below Zone III. You can see why the placement of Zone III is so important. Placing Important Shadow Areas of your subject too low on the Zone Scale is an excellent way to define underexposure. In this example, the model's hair would be lost against the dark interior of the building if it were placed on a zone lower than Zone III.

Areas of the subject that are inherently lighter than the placed shadow value will logically fall on zones above Zone III. If the Important Highlight Areas of your subject fall above Zone VIII, they will be too white in the print or "blocked up," as we say. The relative positions of all the values in the subject are determined by the placement of the Important Shadow Area on the Zone Scale. If you place your shadow value on a lower zone, all the other subject values will be darker. Placing the shadow value higher on the Zone Scale will cause the rest of the subject values to be lighter. I will discuss further implications of this statement in Chapter 6.

Once you have decided on the placement of Zone III, if you carefully meter that area, your last exposure problem is choosing the correct f/stop and shutter speed.

There are only two things you need to remember.

With Hand-Held Meters

1. Whatever light measuring system your meter uses, what it does is recommend an exposure that will print as Zone V unless you change it.
2. Each meter number is equivalent to one zone and/or one f/stop or shutter speed.

With In-Camera Meters

1. Once again, the meter's recommended exposure (when you center the needle or dot), will place whatever the meter is reading on Zone V.
2. Each f/stop or shutter speed is equivalent to one zone.

The first step in determining the correct exposure in this example is to carefully meter the model's hair (previsualized as Zone III). With a spot meter, you could obtain an accurate meter reading without leaving the position of the camera. With a wide-angle or built-in meter, you would have to get close enough to the model for her hair to fill the meter's field of view. You would also have to avoid including the shadow of your hand in the reading. As illustrated in Figure 30, the spot-meter reading for the model's hair is 9. If you were to put meter number 9 under the meter's arrow (blindly following the meter's instructions), the recommended exposure for this portrait would be f/11 at 1/30 of a second.

Note: Remember that in-camera light meters don't have meter numbers and instead, translate light readings directly into recommended f/stop and shutter speed exposures. This will be discussed shortly.

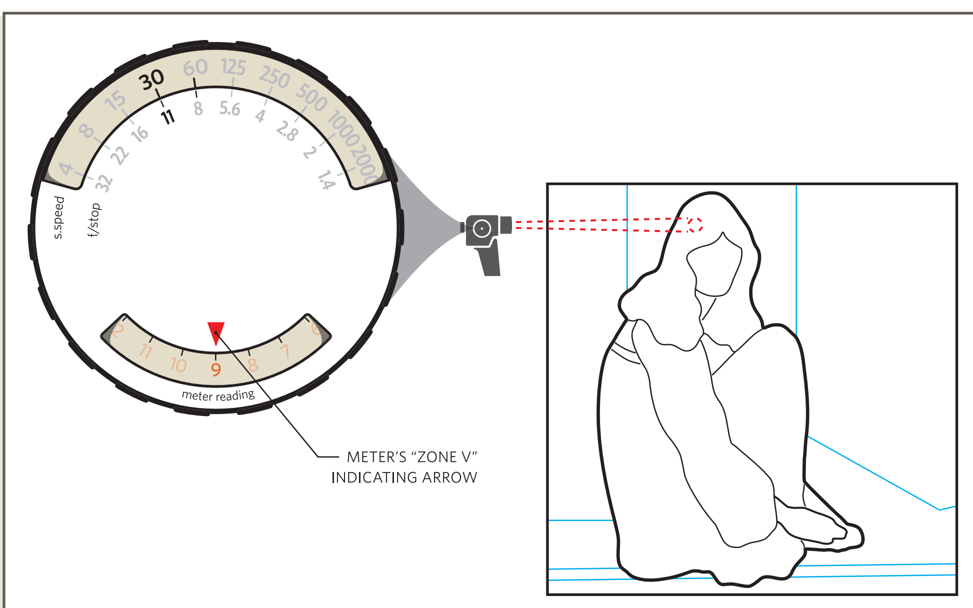


FIGURE 30 Zone V placement of meter number 9 (the model's hair). Meter recommended exposure: f/11 at 1/30 of a second.

Because the meter's recommended exposure will cause her hair to print as Zone V (in this case, two zones lighter than you want it to be), if you **stop down two stops** from this suggested exposure (from f/11 to f/22), you will be placing the meter reading of her hair on Zone III, which is the way it should be printed.

This is a key point, so consider this step very carefully. The reason that you stop down two stops is that one stop less exposure would render her hair as Zone IV, and two stops less exposure will place her hair on Zone III. Frame 2 of Figure 28 was placed on Zone IV.

Of course, you could use either whole f/stops or shutter speeds to make this adjustment because zones, shutter speeds, and f/stops are equivalent. The corrected exposure would then be f/22 at 1/30 of a second.

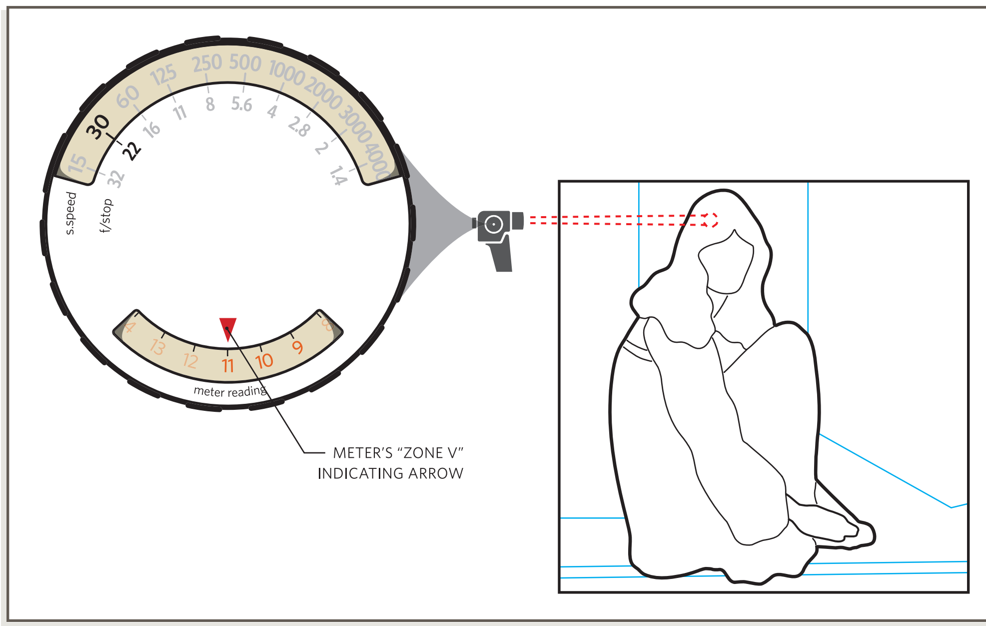


FIGURE 31 Zone III placement of meter number 9 (the model's hair). Corrected exposure: f/22 at 1/30 of a second.

Your concern with determining the exposure of this portrait ends here. The model's hair and the door have been safely placed on Zone III (in this example, the meter reads them both as the same meter number), and the darker parts of the scene are falling on the lower zones where they belong.

Summary

Unfortunately, explaining this procedure in detail makes it appear much more complicated than it really is. In essence, all you have really done is:

1. Decide which areas of the scene you want to be on Zone III in the final print (in this case, the model's hair).
2. Meter that area and make note of the exposure that the meter is recommending, in this case, f/11 at 1/30 of a second.
3. Stop down two stops from this recommended exposure to place her hair on Zone III. The corrected exposure would be f/22 at 1/30 of a second.

If you are using an in-camera light meter, the procedure would be a little different:

1. Previsualize your Zone III area.
2. Get close enough to your subject so that this area fills the viewfinder.
3. Center the needle or dot and note the exposure that the camera's meter is recommending.
4. Stop down two stops from this recommended meter reading to place that area on Zone III.
5. Using this new exposure, step back and take the picture.

See page 74 for a discussion on overriding automatic built-in metering systems.

Some people have difficulty believing that the Zone System is really that simple, or they have trouble "disobeying" their meters. If you think through this example, however, you will see how logical it is.

You now have a completely reliable way of using your light meter as a tool to give you the correct exposure according to your previsualization. If you were to previsualize a light wall as Zone VII and were unconcerned about any shadows that might be in the picture, you would simply meter the wall and open up two whole stops from the meter's recommended exposure. Opening up one stop would place the wall on Zone VI. (See frame 4 of Figure 28.)

Of course, for all of this to work properly, it is important that you use the correct ASA for the film you are using. I will discuss this factor in detail in Chapter 7. The effects of reciprocity failure, filter factors, and bellows extension are covered in Appendix O.

The problem that most beginners have with this process is previsualization. Previsualizing is an act of aesthetic judgment that offers you a wide variety of choices. There are obviously a number of effective ways to interpret any given subject. While you are learning this process, I would suggest that you stick to "normal" previsualizations of your subjects. Later, when you are sure that you can consistently produce realistic results, begin experimenting with alternative ways of seeing.

Other problems that many of us have with previsualizing black-and-white photographs are the associations we have with certain colors. Most people judge a blue object to be darker than a red one, even if both objects are actually reflecting the same amount of light. A handy device for dealing with this problem is a panchromatic viewing filter. Looking through this brown-colored filter removes most of the color from the scene and reveals the inherent contrast as the black-and-white film will see it. A Kodak Wratten Filter Number 90 will give you approximately the same effect and is usually much less expensive.

CHAPTER 6

DEVELOPMENT

Placing an Important Shadow Area on Zone III guarantees that your negatives will be properly exposed but that's only the first step toward creating a perfect negative. In this chapter, we will consider the effect this has on all of the other values of the scene you are photographing.

The two important questions are:

1. Where does the Important Highlight Area fall on the Zone Scale?
2. How does this affect your development time?

As we learned, the rule is: ***Develop for the Highlights.*** This means that the correct development time for a given negative depends on the amount of contrast in each scene you photograph.

At this point, photographers with 35 mm cameras begin to wonder how each frame of a roll of film can be developed individually. The answer is that there is no practical way to do this but there are many ways of adapting roll-film procedures to this rule. I will discuss these after covering the basic theory.

Note: To make these concepts more clear I will be using hand-held meter readings with EV numbers (or simply "meter numbers") in these examples (refer to Chapter 4). See the section Measuring Subject Contrast with In-camera Meters on page 52 for a detailed description of how these principles apply to those meters.

Let's consider the effect of measuring the contrast of different subjects in terms of zones. Once again, imagine that the portrait in Figure 32 is an actual scene you intend to photograph.

The dark foliage behind him was previsualized as Zone III and II and the lighter parts of his wings as Zone VII and VIII. His skin is Zone IV and V and the grass was also seen as Zone IV.

FIGURE 32 Normal Contrast subject. Negative given Normal Development. (By Christine Alicino)

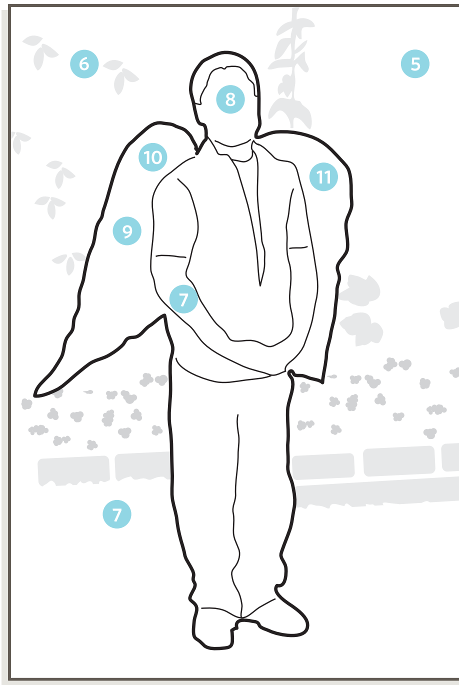


FIGURE 33 Spot-meter EV readings of Figure 32.

Figure 33 indicates the spot-meter readings for the previsualized areas of the subject. The numbers indicated are the average meter readings of those areas.

Although for the sake of this example I have listed a number of different readings, it's very important to understand that, in order to measure the contrast of any subject, you always have to make **at least two readings:** one of the Important Shadow Area, and one of the Important Highlight Area. In the real world, none of the other meter readings are strictly necessary and this vastly simplifies the process of using the Zone System.

After you have previsualized your subject, the first step toward measuring its contrast is to place the Important Shadow Area on Zone III. Placing the foliage (meter number 6) on Zone III can be diagrammed like this:

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
METER NUMBERS				6						

FIGURE 34A EV meter reading number 6 placed on Zone III.

Maintaining the "one meter number for one zone" relationship, the other EV meter readings for this scene can be filled in under the appropriate zones as follows:

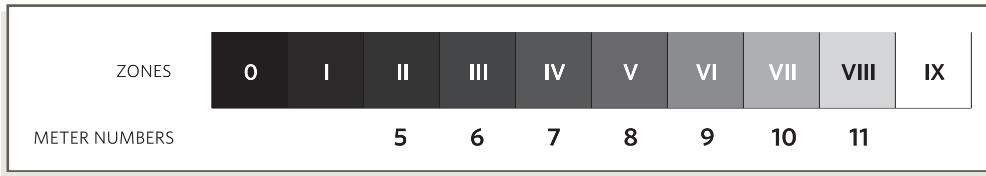


FIGURE 34B EV meter number 10 falls on Zone VII.

The principle at work here is very simple. After the selected subject value has been placed on a zone (in most cases you will be placing the Important Shadow Area on Zone III), all the other subject values have to fall on the other zones of the scale. The specific zones on which the other EV meter readings fall will depend on how much lighter or darker they are than the placed value. In this way, you are actually **measuring the contrast of your subject in terms of zones.**

A good analogy for this process would be measuring a piece of fabric. Imagine that the cloth is five inches long (or five zones in this case). If you "place" one end of the fabric on the three-inch mark of a ruler, the other end of the cloth has to "fall" on the eight-inch mark.

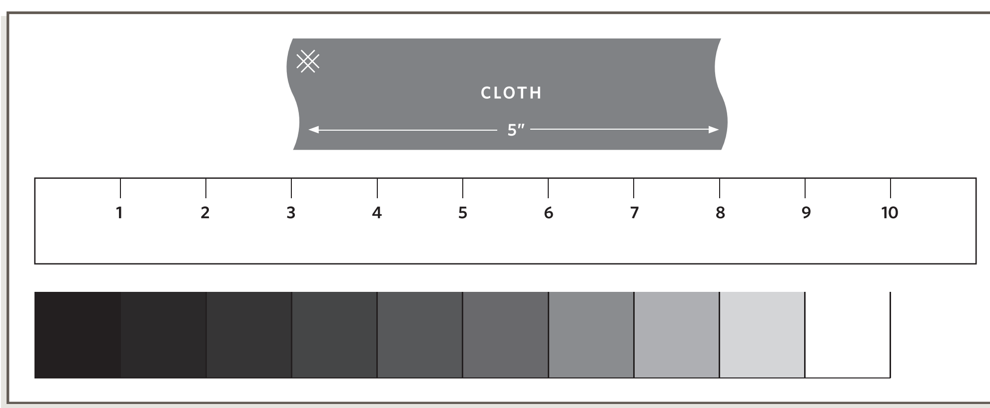


FIGURE 35 After one end is "placed" the other end "falls."

In this first example, we're using the Zone Scale to measure the portrait's range of contrast by seeing where the EV meter readings of the relevant subject areas fall. As you can see in Figure 34b, placing meter number 6 on Zone III means that meter number 5 has to fall on Zone II, because the darkest foliage on the right is reflecting one-half as much light as the foliage on the left. EV meter number 7 has to fall on Zone IV because the subject's skin is twice as bright. We can now say that this scene has a range of fully textured contrast equal to five zones, from Zone III (meter number 6) to Zone VII (meter number 10). The other zones in this scene add depth and brilliance to the print but the five textured zones between III and VII are most important for determining the proper exposure and development.

Having placed EV meter number 6 on Zone III, meter number 8 will fall on Zone V. If you move the arrow on the meter's dial to that number, you will have all the correct exposures for this portrait.

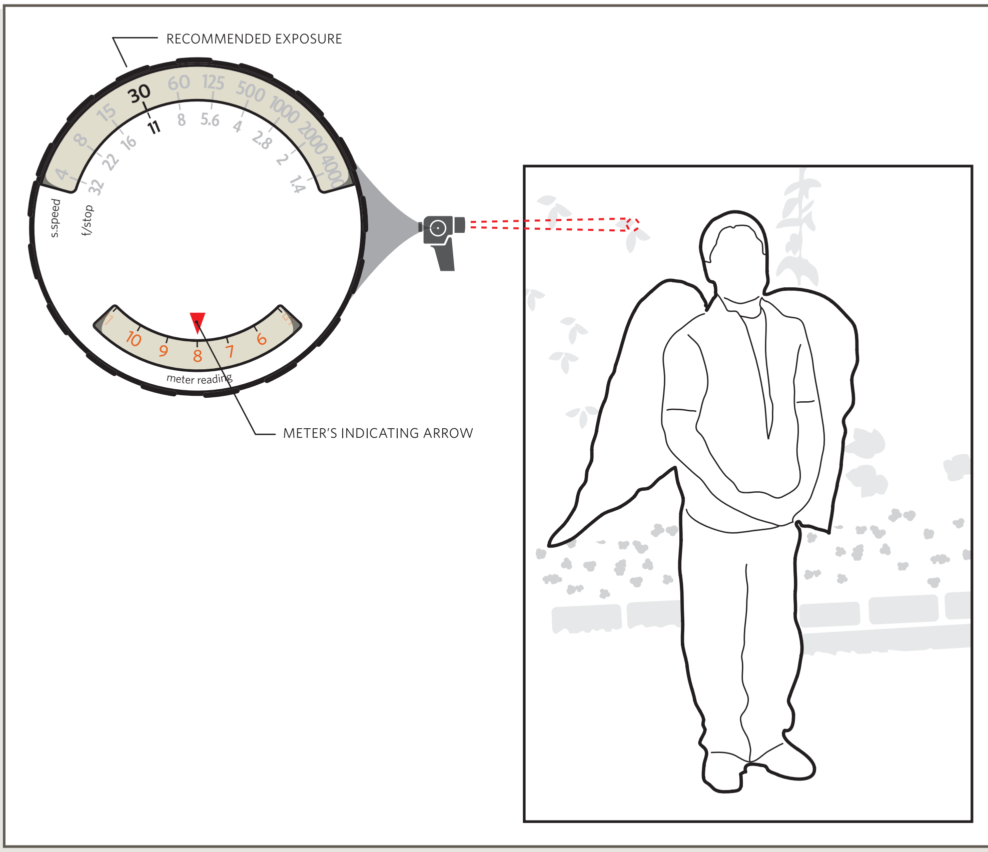


FIGURE 36 Placing meter number 6 on Zone III.

Notice that in this example the correct exposure is indicated as **1/30th @ f/11.** Keep this reading in mind. I'll be referring to it in the next example.

Think this through: The meter's indicating arrow is always in the correct position when it is pointing to the number that you want to fall on Zone V. Your Zone III placement will **always be two meter numbers less** than this Zone V number. This suggests a simple method of operating your meter. After you determine what meter number you want to place on Zone III, simply **add 2** to that number and move the indicating arrow to the result. See Figure 36.

Now that we have used the Zone Scale to measure this scene's contrast, all that remains is to see how this compares with our previsualization.

Remember that we previsualized this portrait as follows: the lighter foliage on the left as Zone III, and the wings on Zones VII and VIII.

Figure 37 on the next page shows that all of the key meter readings of this scene are falling on the appropriate zones.

We can now make a general statement that defines a precise method of determining how to properly develop your film:

When a subject value previsualized as Zone VII falls on that zone after the Important Shadow Area has been placed on Zone III, the contrast of the scene can be considered Normal and the negative should receive Normal Development.

FIGURE 37 Zone placements of Figure 32.

Remember that Normal Development is the standard development time for a given film and developer that will give you contrast in the negative equal to the contrast of the scene. (Refer to Chapter 3.)

Because the contrast of this portrait is Normal (and because the placement of the shadow value is correct), Normal Development will result in a negative that will print well on a normal grade of paper, usually grade or filter 2. Of course, the effective Normal Development Time for your film and developer can only be determined by testing them under controlled conditions. Chapters 8 and 9 offer very simple methods of testing various films and developers.

Note: Keep in mind that by "Normal" contrast I don't mean that all the subject's values must fall exactly on the previsualized zones. What I mean is that the overall contrast of the scene should match the normal limits of the film and paper and that all the other middle values of the subject will fall somewhere within the five zones of the textural scale. In other words, don't be surprised if the meter reading for the face in a portrait falls on Zone V 1/2 or VI 1/2. Even when you are working with properly exposed and developed negatives, it is necessary to dodge and burn in selected areas of the print to add emphasis or to correct tonal imbalances. Fine printing will always be an art unto itself.

Let's review what we have done so far:

1. First, meter the area that you have previsualized as the textured shadow area and place that meter reading on Zone III. See Figure 34a.
2. Next you should note which meter number falls on Zone V and turn the meter's Zone V indicating arrow to that number to determine the correct exposure. See Figure 36.
3. If the meter number for the area of the subject you want to print as Zone VII falls on that zone, you should give the negative Normal Development. See Figure 37.

Measuring Subject Contrast with In-Camera Meters

The principles you have just learned apply as much to in-camera meters as any other type, but the above examples may have been confusing because in-camera meters don't use meter numbers like those used in my illustrations.

Instead of using EV numbers, an in-camera meter translates its readings of the Important Shadow and Highlight areas directly into recommended f/stop and shutter speed combinations. Let's briefly review how this works.

In-camera light meters have various ways of telling you that, "this is the correct exposure." When they are set to any of their automatic modes they simply read out a given combination of aperture and shutter speed. When they are in a manual mode you have to change your aperture or shutter speed until your electronic display is centered. As we learned in the previous chapter, in either of these cases, the exposure that results will cause what the meter is seeing to print as Zone V.

The important thing to remember is that when the meter is seeing something that you want to print as Zone III, the meter's recommended exposure will be two full stops too light!

Conversely, if the meter is pointing to something you want to be Zone VII, its recommended exposure will be two stops too dark.

This translates into a reliable way to use in-camera meters to measure the contrast of any subject.

To make the steps in this process more clear it's useful, when you are beginning to learn this system, to use a Zone Metering Form as illustrated in Figure 38 to organize your readings.

See Appendix Q for a blank version of this form that you can copy for this purpose.

As I mentioned above, in order to measure the contrast of any scene you have to make at least two meter readings; one of the Important Shadow and another of the Important Highlight.

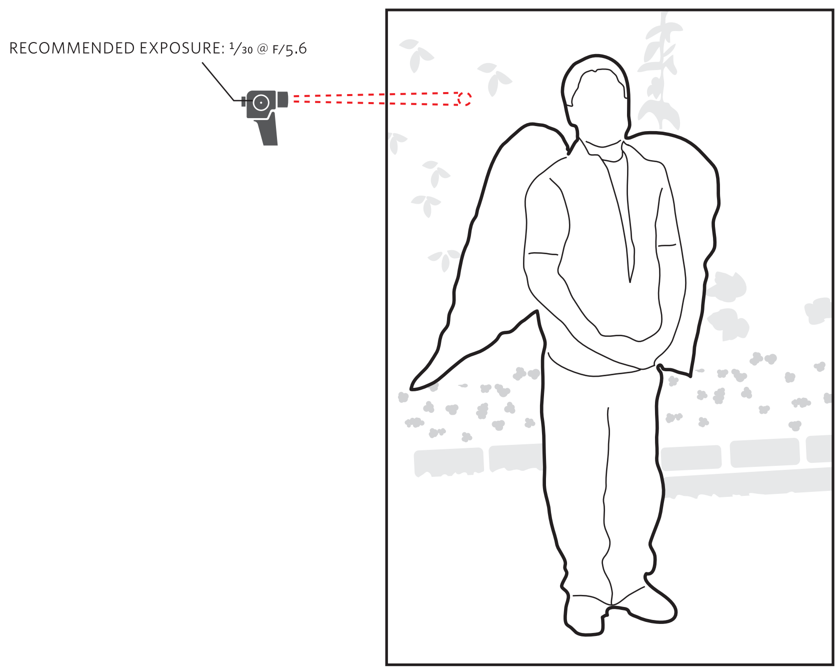
To simplify the process of comparing these two readings, think of either your shutter speed or your aperture as the Reference Reading that will remain the same from one reading to the other. I normally use the shutter speed as my fixed Reference Reading and apertures as Measurement Readings that change, as you will see in the following example.

Looking again at the portrait in Figure 32, here is how you would use the Zone System to measure the contrast and determine the proper exposure using an in-camera meter.

Note: **Either Manual or Automatic modes can be used for this process.**

1. Get close enough to fill the frame of your camera with the Important Shadow Area (previsualized in this case as Zone III).

Take a careful meter reading of that area and make note of the meter's recommended exposure. In this example the meter reading is 1/30th @ f/5.6.



APERATURES	F/64	F/45	F/32	F/22	F/16	F/11	F/8	F/5.6	F/4	F/2.8
SHUTTER SPEEDS	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
						N+2	N+1	N	N-1	N-2
MEASUREMENT READINGS				5.6	8	11	16	22		

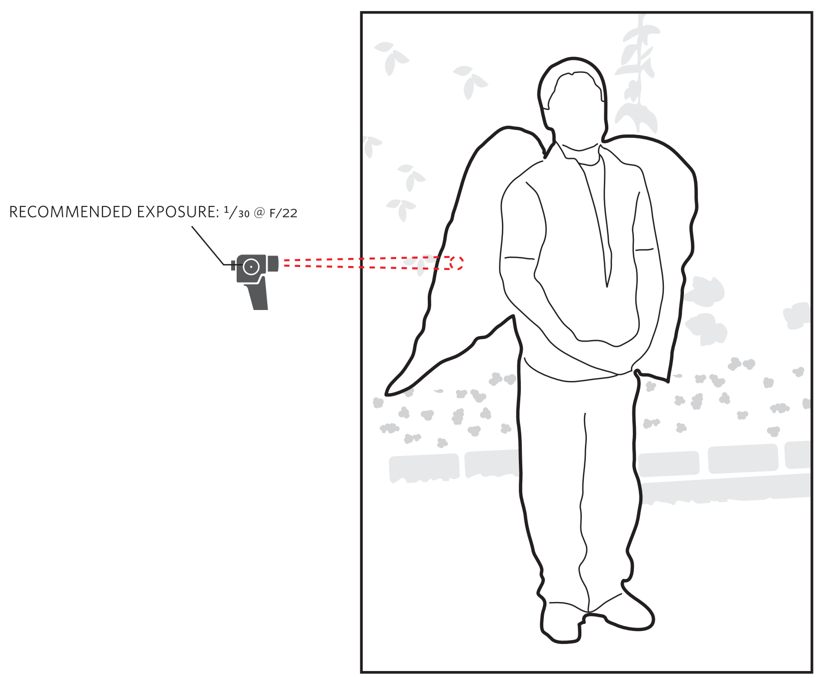
REFERENCE READING: 1/30

FIGURE 38 In-camera metering the Zone III area. Meter reading: 1/30 @ f/5.6

Note: The Normal Plus and Minus designations I've added to the above Zone Metering Form are intended to give you guidelines for determining your development times, but remember that these will only apply when your goal is to use Zone VII as your Important Highlight.

2. In this example I'll use the shutter speed as my Reference Reading so I entered 1/30 in the box provided for that purpose.
3. This next step is very important to understand!
   Since f/5.6 is the Measurement Reading I got for the area previsualized as Zone III, I entered 5.6 in the Zone III box in the chart.

4. I then entered all of the corresponding full aperture readings under the zones where they fall.
   The reason why the apertures are entered in the order as illustrated is because the light meter recommends smaller and smaller apertures when it records brighter and brighter subject values. As you learned in the previous chapter, this is because the meter is attempting to render those increasingly light subject values as Zone V; middle gray.
5. The next step is to take a careful meter reading of the Important Highlight Area (previsualized as Zone VII) using the same shutter speed as the previous reading. In this example the reading is 1/30 sec @ f/22.



APERATURES	F/64	F/45	F/32	F/22	F/16	F/11	F/8	F/5.6	F/4	F/2.8
SHUTTER SPEEDS	1/500	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
						N+2	N+1	N	N-1	N-2
MEASUREMENT READINGS				5.6	8	11	16	22		
REFERENCE READING						1/30				

FIGURE 39 In-camera metering the Zone VII area. Meter reading: 1/30 @ f/22.

Analyzing our chart after it has been completed in this way indicates a number of very important things.

First notice that the aperture that falls under Zone V is f/11. As we saw in the previous example, **this is the correct exposure for this subject.** We would have gotten exactly the same result if we had simply measured the Important Shadow Area and stopped down two stops from 1/30th @ f/5.6.

The second thing to notice is that the Measurement Reading of f/22 that we got for the Important Highlight Area is falling under the Zone VII section of the chart.

Because this matches our previsualization of this subject we can once again say that this scene has normal contrast, and that we should give the film Normal Development.

Take the time to carefully review these steps until this process is clear to you.

Normal Plus Development

Of course, in real life, things seldom work out as nicely as the previous example. Very often you will find yourself having to deal with subjects where the contrast is either too great or too flat to print easily on your favorite grade of paper.

In this next example, the problem is making a printable negative from a scene that has *too little contrast*. The photograph in Figure 40 was taken on a very gray and overcast day. The print is dull and lifeless because the negative was given Normal Development and printed on a Normal grade of paper. Remember that by definition, Normal Development results in negative contrast that is the same as your subject contrast (refer to pages 56 and 57).

FIGURE 40 Low-contrast subject. Negative given Normal Development.

In this case, the model's hair and shawl were previsualized as Zone III, her face as Zone VI, and her shirt as Zone VII. Figure 41 shows the EV meter readings for these areas of the portrait.

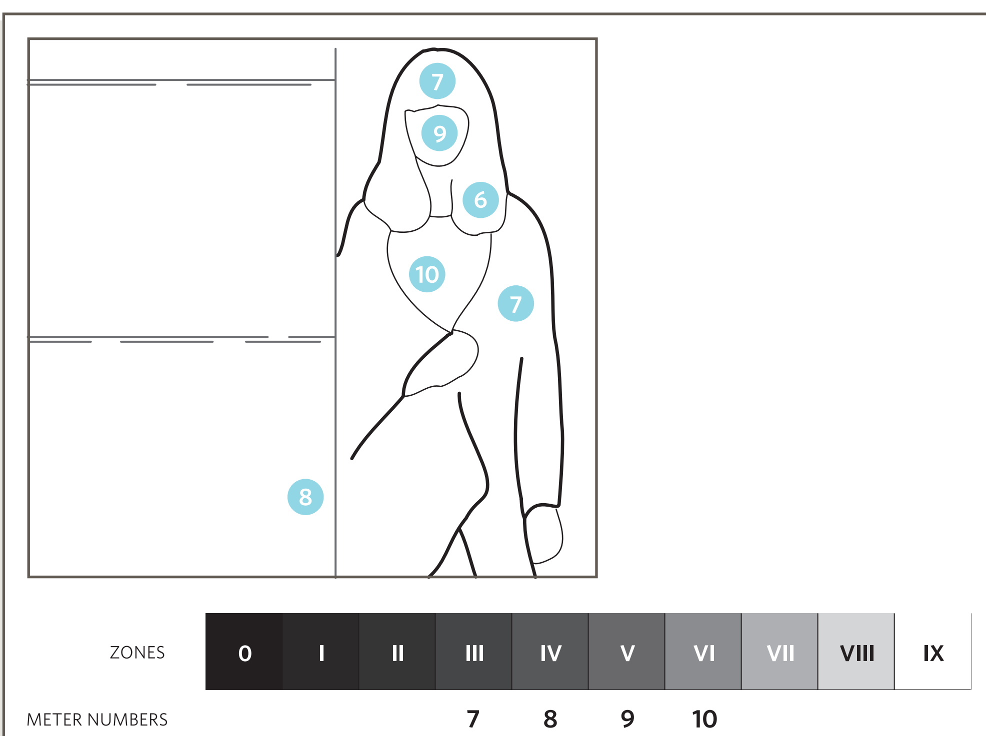


FIGURE 41 Spot-meter readings and zone placements of Figure 40.

FIGURE 42 Low-contrast subject. Negative given N + 1 development.

When you place the Important Shadow Areas on Zone III (in this case, both her hair and shawl read meter number 7), notice that the meter reading for her face (9) falls on Zone V, and the reading for her shirt (10) falls on Zone VI. As you can see, all the Important Highlight Areas of this subject are falling **one zone below** where you want them to be according to our previsualization. **The remedy is to expand the contrast of the negative with increased film development.**

As always, you can determine the correct exposure by turning the meter's indicating arrow to the number that falls on Zone V, in this case meter number 9.

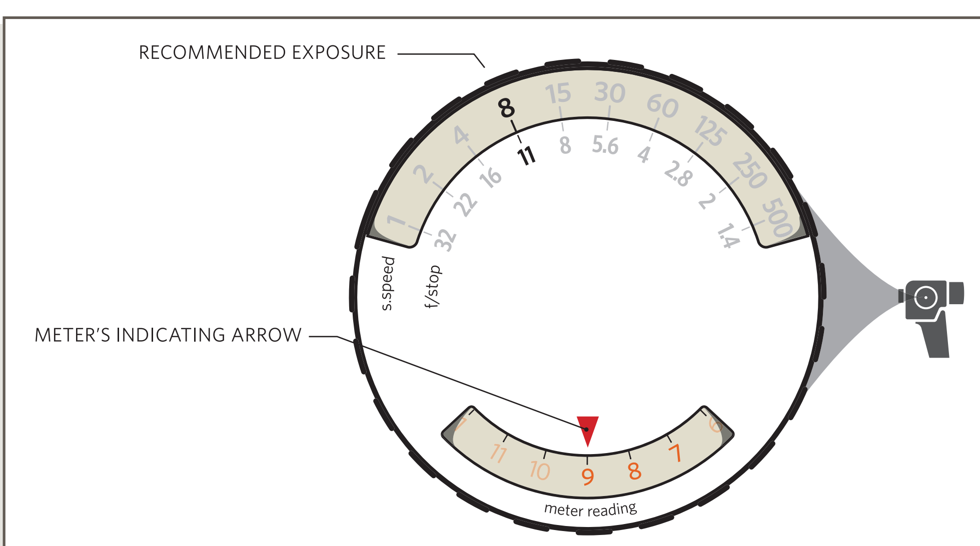


FIGURE 43 Zone III placement of meter number 7.

To compensate for the lack of contrast in this subject, you must increase the development time of the negative enough to raise a Zone VI negative density to Zone VII and a Zone VII density to Zone VIII. This increase is called **Normal development plus one zone,** or **N + 1.** Remember that increasing the development time does not affect the shadow densities nearly as much as it does the highlights (refer to Chapter 3).

By systematically increasing the highlight densities by one zone, you can produce a negative that has properly exposed shadows and more contrast than the original scene. The resulting print matches our previsualization and has a much better sense of light.

Figures 44 and 45 illustrate the effects of N + 1 and N + 2 development, respectively.

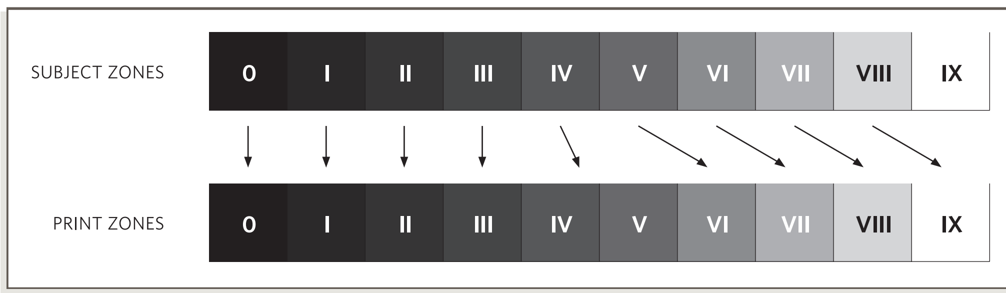


FIGURE 44 The effect of Normal Plus One (N + 1) development.

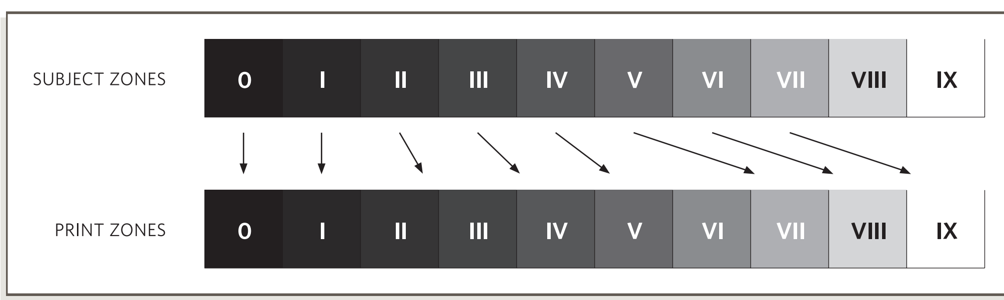


FIGURE 45 The effect of Normal Plus Two (N + 2) development.

The lines labeled "Print Zones" represent the zones of the subject as you previsualize them in the final print. The lines labeled "Subject Zones" represent the contrast of flat subjects measured in zones.

Notice that when a negative is given N + 1 development, Zones VI, VII, and VIII will increase in density by **one full zone.** The zones that are below Zone V increase much less. Zone IV increases by only one-half of a zone, and Zone III *hardly moves at all.*

For this reason Zone V can effectively be considered the borderline between the zones that will increase *proportionately* with longer development and those that won't. Because the zones below Zone V increase in density at a much slower rate, increasing the development time of the negative increases its contrast. You can determine the exact times for negative expansions by doing tests that are outlined in Chapters 8 and 9.

To summarize, the way to produce usable negatives from subjects with very little contrast is to *expose for the shadows*, then *increase* the negative's development time enough to raise the highlight densities to the proper previsualized zone.

Note: Extreme Normal Plus Development will result in grainier negatives, which could be a problem for those working with roll-film cameras. An alternative method for increasing the contrast of 35 mm negatives without added grain would be to intensify your film in selenium toner. For more information about this process, refer to Appendix H.

A good question to ask at this point would be, Why not simply place the shadow reading in this example (meter #7) on Zone IV instead of Zone III? Your placement would then look like this.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
METER NUMBERS					7	8	9	10		

FIGURE 46 Meter number 7 placed on Zone IV.

The highlight reading is now falling on the proper zone, but notice that you have effectively overexposed the negative without increasing its contrast. The result would be a print with gray, flat shadow areas.

Normal Minus Development

The problem in this case is the opposite of the one in the previous example. Here the combination of bright sunlight and white surfaces causes this to be a very contrasty photographic subject. The goal is to show detail in the shadow areas (in this case, the model's shawl) while maintaining the subtle texture and brilliance of the highlights.

If you were to place the shadow readings on Zone III and give the film Normal Development, the result would be a negative with overly dense highlights. In the print, these nearly opaque densities will appear as empty, glaring whites with no tonal separation or surface detail.(See Figure 47).

Notice that the shadow areas are properly rendered, indicating that the exposure is correct but that the highlights are washed out. A reduction in the negative's development time is required, but the question is how much?

The model's shawl is previsualized as Zone III, her face as Zone VI, the shadows on the wall as Zone V, the sunlit wall as Zone VII, and her white jacket as Zone VIII. Figure 48 indicates the spot-meter readings for these areas.

FIGURE 47 High-contrast subject. Negative given Normal Development.

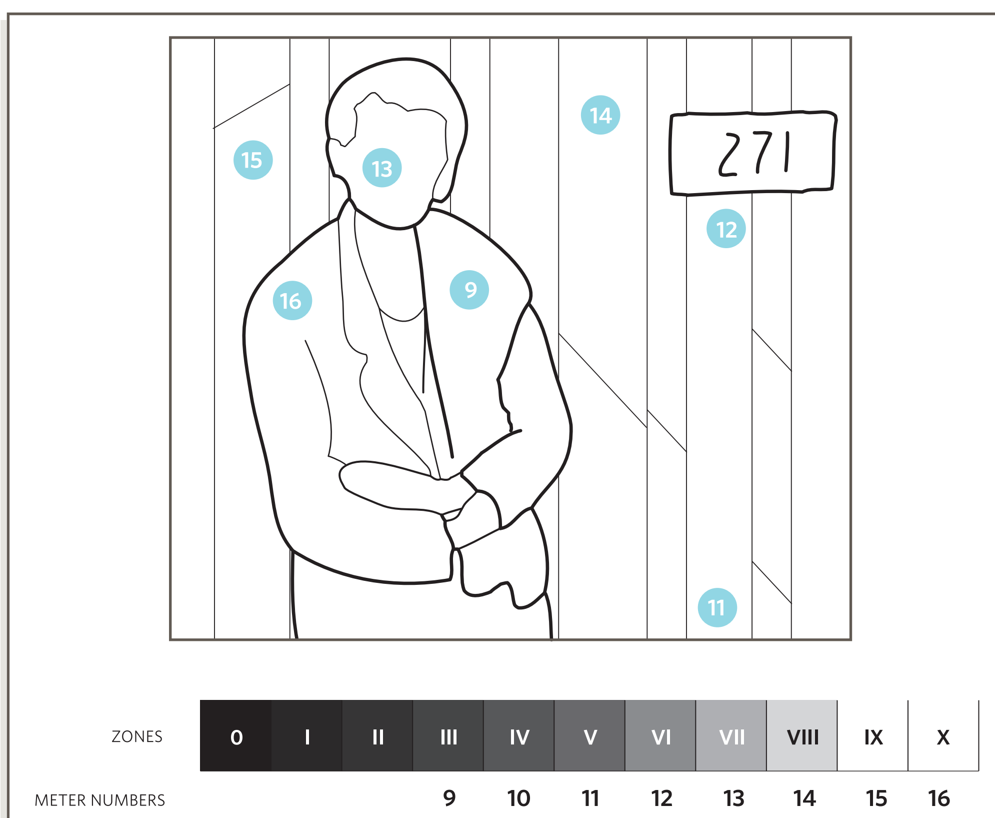


FIGURE 48 Spot-meter readings and zone placement of Figure 47.

FIGURE 49 Highcontrast subject. Negative given N − 1 Development.

Don't be confused by the sudden appearance of Zone X. For the first time we are using the Zone Scale to measure the contrast of a very contrasty scene. The extra zone space simply gives us a place to record where this very high reading falls.

As you can see, when meter number 9 is placed on Zone III, all the highlights fall **one zone higher** than our previsualization. The correct exposure is determined by turning the meter's arrow to 11 (Figure 50).

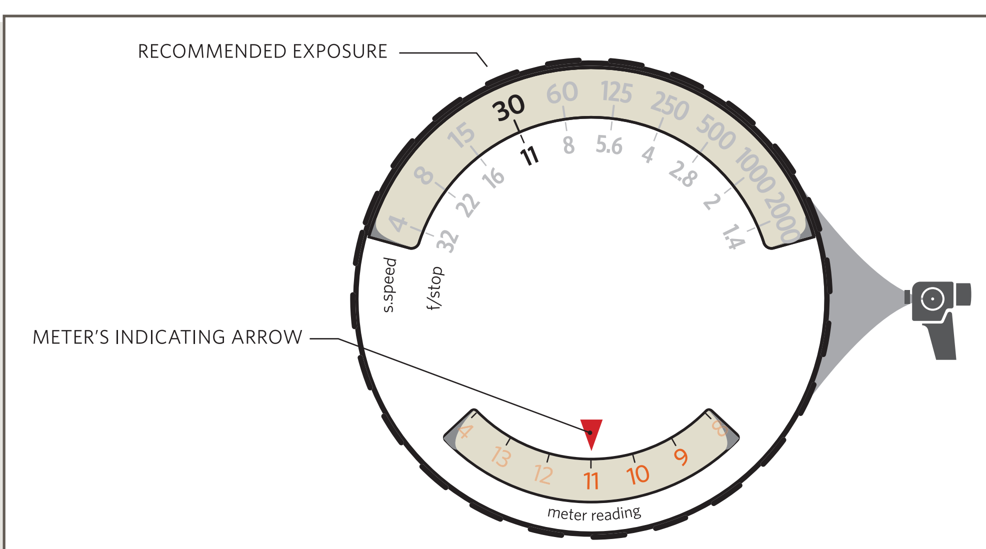


FIGURE 50 Zone III placement of meter number 9.

The next step is to give the film less than Normal Development to reduce the density of the negative's highlights. Because the highlights of this portrait are falling one zone too high, the correct development time for this negative would be **Normal Minus One zone**, or **N − 1** (Figure 49).

The resulting print has well-detailed shadows and textured, luminous highlights.

The effects of **N − 1** and **N − 2** Development are illustrated in the following examples.

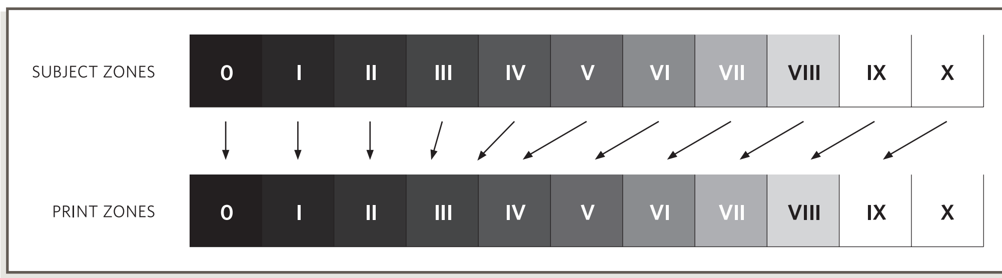


FIGURE 51 The effect of Normal Minus One (N − 1) Development.

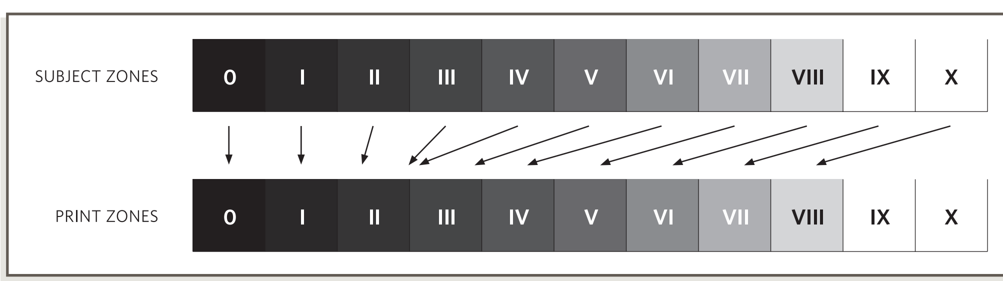


FIGURE 52 The effect of Normal Minus Two (N − 2) Development.

Notice that with **N − 1** Development, a Zone VIII negative density is reduced to a density equivalent to Zone VII, while Zone IV only decreases to Zone III 3/4. Because the higher zones decrease in density much more than the Zones below Zone V, **shortening the development time has the effect of reducing the overall contrast of the negative.** Again, you can determine the exact times for negative contractions by testing your film and developer. It is important to note that when the film is given less than **N − 2** Development, there is a noticeable loss of negative density in the lower zones. The remedy for this problem is simply to remember to place your Textured Shadow reading on Zone IV instead of Zone III when the contrast of the scene is extremely high. For further discussion of the effects of extreme Expansion and Contraction, refer to Appendix H.

CHAPTER 7

AN OVERVIEW OF THE ZONE SYSTEM

This chapter briefly summarizes the Zone System method of exposure and development and answers a number of questions usually asked by students at this point in the process.

What we have learned is that when the contrast of the subject photographed is flat or contrasty it is necessary to control the contrast of your negatives.

Here are the general steps for producing consistently printable negatives:

1. Previsualize your subject in terms of the finished print. This means that you should mentally assign a zone to the important textured shadow and highlight areas of the subject.

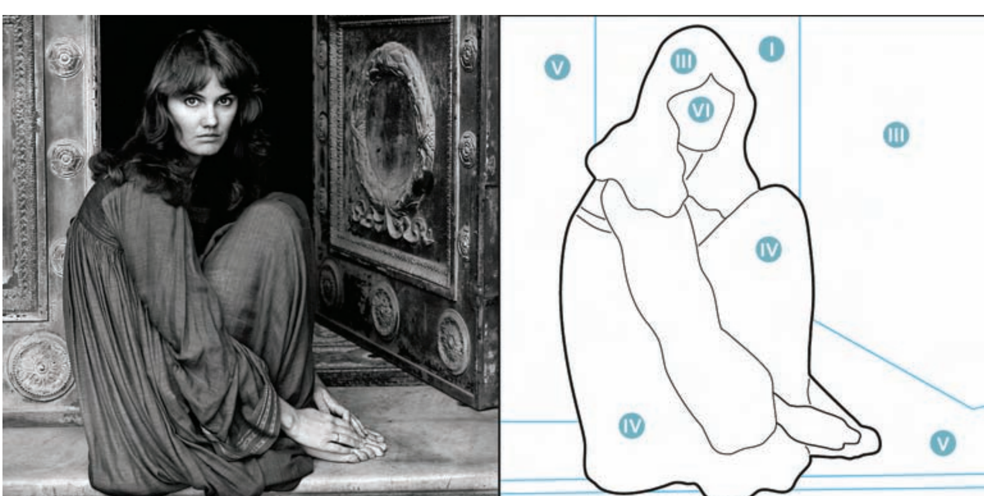


FIGURE 53 Previsualization.

To choose the correct exposure you need to decide which parts of the picture you want to be Zone III. Zone III is the zone for the area of the subject that you want to print as a fully textured shadow value.

2. Determine the correct exposure by carefully metering the Important Shadow Area and placing it on Zone III. This is done by stopping down two full stops or shutter speeds from the meter's recommended Zone V exposure for that area.

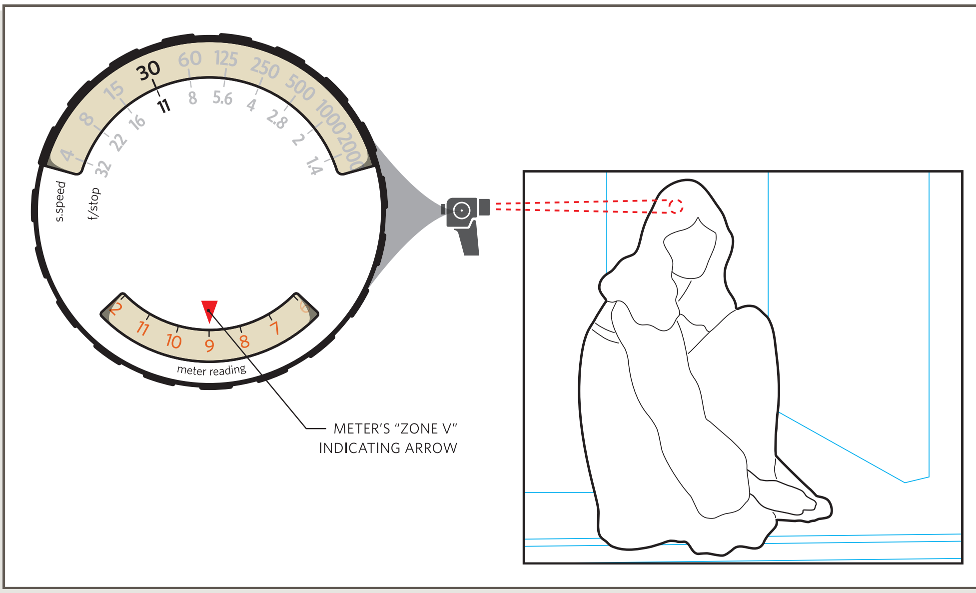


FIGURE 54 Placing meter number 7 on Zone III, the correct exposure for Figure 53 is f/11 at 1/30 of a second.

To determine the correct development time for the negative you need to identify the Zone VII area of the subject. Zone VII is the zone for textured highlights. (See Figure 53.)

3. Measure the subject's range of contrast in terms of zones by plotting the meter readings of the scene against a Zone Scale.

The specific method you use for this step depends on the type of light meter you are using.

With hand-held spot meters that read with EV numbers what you would do is write the EV reading of the Textured Shadow Area on the form under Zone III, then apply the rule: One meter number equals one zone.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
METER NUMBERS		5	6	7	8	9	10			

FIGURE 55 Placing the textured shadow reading on Zone III.

With in-camera meters you learned the two-step process that uses an Zone Metering Form:

- The first step is to enter the Reference Reading that will not change between your Important Shadow and Highlight readings in its designated box.

- For step 2 you meter the Important Shadow Area and write the Measurement Reading under the Zone III section of the chart. All of the other Measurement Aperture Readings fall on corresponding zones on the chart.

Remember that the Measurement aperture reading that falls on Zone V, together with the Reference Shutter speed is the correct exposure for this image.

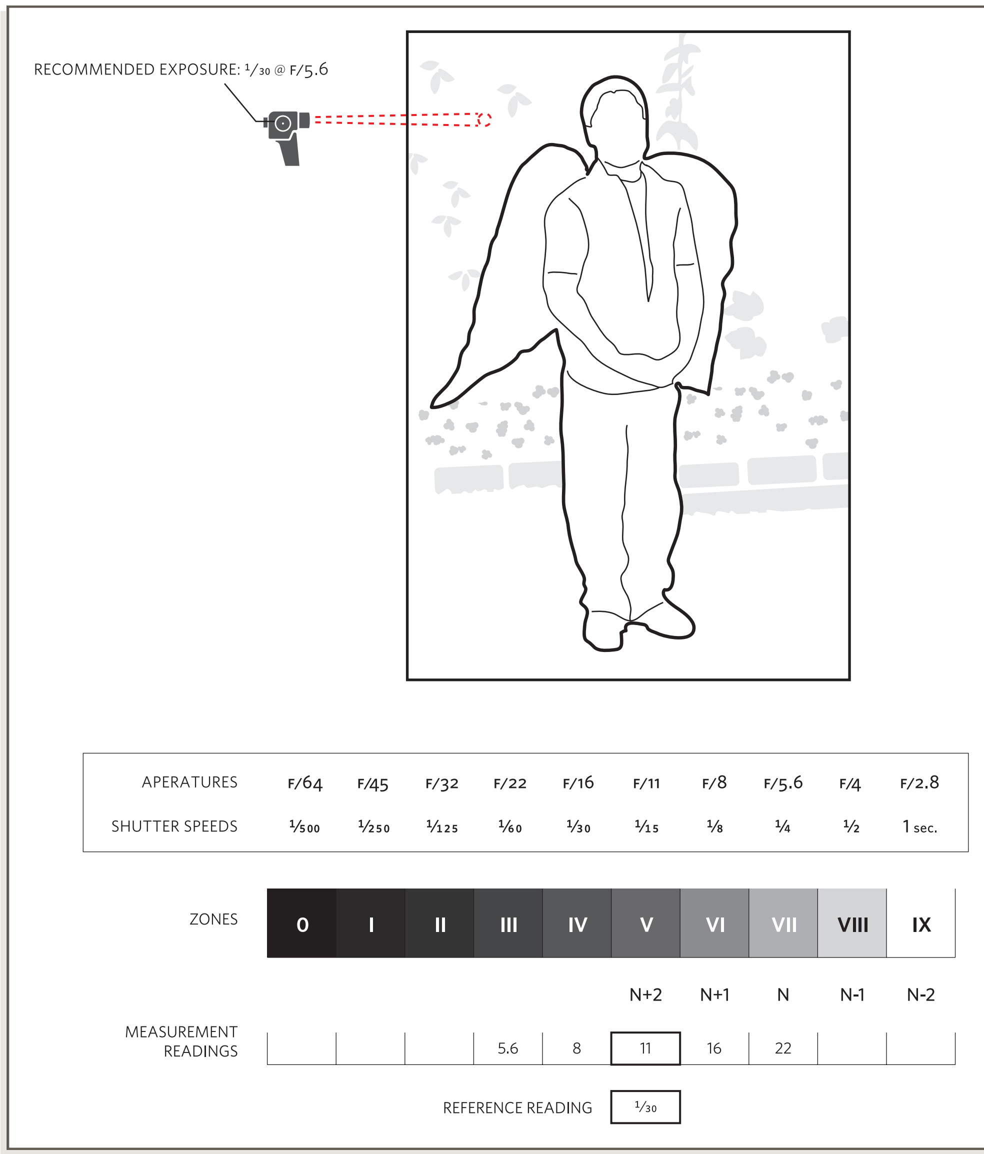


FIGURE 56 Zone Metering Form of in-camera readings.

4. Determine the correct development time for the negative by carefully metering the areas that you have previsualized as Zone VII (or Zone VIII depending on the subject matter). If this meter reading falls on the proper zone after the textured shadow has been placed on Zone III, give the film Normal Development.
5. If the meter reading for the Important Highlight Area falls above or below the previsualized zone, increase or decrease the film's development time according to how many zones away from the previsualized zone it falls.

   For example, if the Important Highlight Area falls one zone above the previsualized zone on the Zone Scale, the recommended development time would be Normal Minus One zone (**N** − 1).

   These numbers should be written directly on the film holder or cassette to avoid confusion.

Expose for the Shadows and Develop for the Highlights

The Zone System method of negative contrast control is as simple as that. Once you appreciate the importance of properly exposing and developing your negatives, it simply becomes a matter of working with the system long enough for the principles to become familiar. Your first attempts at applying the Zone System to your photography might make you very aware of other weaknesses in your technique. No system, however logical or straightforward, can compensate for faulty equipment or carelessness. But, if you are persistent, you will eventually work out all the bugs and develop your own set of shortcuts. At that point, your work will begin to flow smoothly.

One of the first steps in this process is losing your anxiety about making a mistake. This is why the test outlined in the next chapter is so important. After you produce your first successful print with the Zone System, the mystery will disappear.

One of the misconceptions about the Zone System is that it will make photographic printing routine. The goal is not to make photography an exact science but rather to allow photographers to concentrate on the parts of the process that require intuition and imagination. What you will find is that a little bit of understanding and control will go a long way toward solving your technical problems. Once the negative is made, the issue becomes how to best interpret it through creative printing.

When you begin using the Zone System, you may encounter some of the following problems.

First, you may have trouble previsualizing the subject in terms of zones. Any new system takes a while to get used to, but before long you will find that it comes naturally. Keep in mind that for the purpose of determining the correct exposure, the only question you need to answer is Where is the area that I want to be Zone III? Look for an area of the subject that would spoil your photograph if it were too dark in the finished print. Most likely this is the area you want to place on Zone III. Again, it is useful to spend time studying other photographers' work to help you develop a sense of your own standards. If you have a 4 × 5 view camera with a Polaroid adapter back, it is a good idea to practice previsualizing a variety of subjects to see how the results either confirm or modify your previsualizations. You may also try using a panchromatic viewing filter as an aid.

The second important question you need to answer for the correct development time is Where is the Zone VII area of this subject? Practice will make this easier, but a good rule of thumb is, if the area in question is light colored and textured, call it Zone VII.

It is easy to overdo trying to pinpoint specific zones. At first it may be difficult to "see" Zone VII when the contrast of the subject is very flat. The lack of an obvious light value in the subject could make previsualizing Zone VII seem illogical. It could also be that you might not want a Zone VII in that particular image. In this case, consider Zone VI to be the Important Highlight zone for this image and develop the film accordingly.

This also applies to Zone III. If you decide that Zone II is the appropriate zone for the Important Shadow Area of your subject, place your meter reading on Zone II and start from there. (The only danger with this approach is that you cannot change your mind after taking the picture and give that area more exposure later.) The purpose of the Zone System is to give you creative control, not to lock you into hard and fast aesthetic limitations. Whenever you are in doubt about how to proceed with a given image, make a decision and pay careful attention to your results. Be sure to keep careful records when you are unsure. In general, you can count on the obvious associations I have mentioned before. Light clothing, concrete, and white objects in the shade are usually Zone VII. Dark foliage, dark clothing, and brown hair are commonly Zone III. Paper and white objects in sunlight are generally Zone VIII.

Zone System beginners often become confused about which way to turn the meter dial to place a shadow value on Zone III. At first it is easy to turn the dial the wrong way and drastically overexpose the film. I would say that this is by far the most common mistake made by students when they first begin learning the system. The key is to remember that you are trying to make the Zone III area of the subject darker than the meter is telling you to. This is because Zone III is **darker** than Zone V.

As you turn the dial, watch to see whether the exposures are becoming longer or shorter. If, for example, turning the dial to the right decreases the exposure, memorize that direction for future use.

Many light meters have enough room adjacent to the meter numbers to attach a small Zone Scale like the one illustrated in Figure 57.

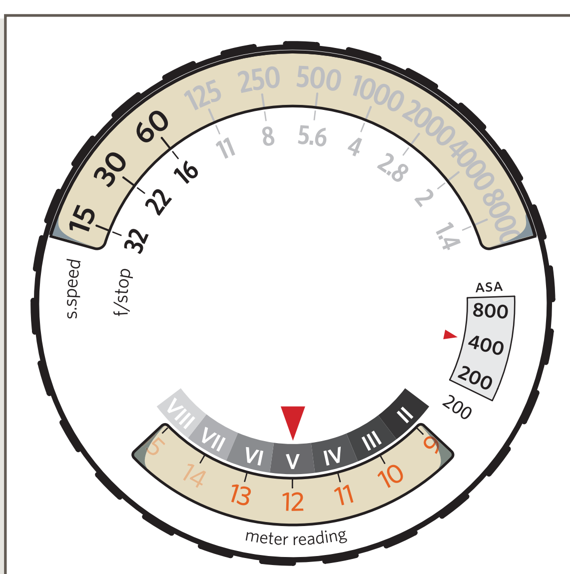


FIGURE 57 How to place meter number 10 on Zone III using a Zone-Scale decal.

Self-adhesive decals of this kind were once available from Fred Picker's Zone VI Studios. These days I would suggest that you simply create one for yourself if this is possible on your meter. Make sure you line up the scale with the Zone V section over the meter's indicating arrow. A scale like this will make zone placement and contrast measurement ridiculously easy. For example, when you want to place a given meter number on Zone III, all you need to do is turn the dial until that number is under the Zone III section of the scale. You can now read the correct exposures and the relative positions of all the other meter numbers directly from the dial. A visual aid like this makes it very easy to think through the placement and exposures you will want to use. Actually seeing the meter readings falling on the rest of the scale will make the process much more concrete.

Another common problem is faulty equipment. After carefully metering, exposing, and developing an image, you may discover that it is ruined because of a seriously inaccurate light meter or shutter. You are less likely to notice a problem like this when you aren't sure of what you are doing in the first place. It is a good idea to take your meter and shutters to a good camera repair store to have them checked before you begin trying to improve your technique.

Zone System Frequently Asked Questions

Let's consider some of the questions commonly asked about the Zone System.

Q: The procedure you have described is fine for situations where there is plenty of time to take careful readings. What should I do if I have to shoot quickly?

A: In all of the previous examples, I have included meter readings for all the important areas of the subject in order to make the process more clear. Practically speaking, there are only two meter readings that you absolutely must make. You need one reading of the Important Shadow Area to calculate the exposure (at this point, you can take the picture); and one reading of the Important Highlight Area to determine the proper development time. You will need to write this down so you will know how to process the film. Unless the light changes while you are shooting there is no need to recalculate the exposure. Try to simplify your methods as much as possible.

Q: I can understand how the Zone System would be easy to use with a view camera where each frame is developed individually, but how can I apply these methods to roll film?

A: The process for using in-camera light meters along with the Zone Metering Form that I outlined in Chapter 6 makes applying the Zone System to roll-film cameras relatively simple. But, now that you are aware of the relationship between the contrast of your subject and the negative's development time, you will find yourself automatically adapting your shooting methods to ensure that the roll for each subject is developed properly. The problem most photographers have is that they are unaware that this connection exists at all. In most situations, this won't be a problem. For example, if you are shooting outdoors on a clear day, you will find that the contrast won't change very

much. Take one set of readings, shoot the whole roll, and indicate on the cassette how it should be developed. If you are in the middle of a roll and you find that the contrast is changing, either because you have to change locations or because of a change in the incident light, you have two choices. You can either quickly shoot the rest of the roll and start another, or take another set of readings and make note of how much difference there is between the contrast of the two scenes. If there is less than one stop's worth of difference in contrast (i.e., if the first scene required Normal Development and the second situation calls for N + 1), don't worry about it. Just recalculate the exposure for the second scene and count on higher or lower grades of paper to compensate for the difference. If the difference is much greater than this and you can't change rolls, you may have to sacrifice the contrast of one scene or the other when you develop the roll or split the difference in development (i.e., if one situation required N − 1 and the other N + 1, you should develop the roll using Normal Development). A good rule of thumb for roll-film photographers is when in doubt, overexpose and underdevelop. It is much easier to compensate through careful printing for a slightly flat negative than for one that is too contrasty. Also, the reduced development time will minimize grain.

You will find that ingenuity and compromises are sometimes necessary when using roll-film cameras in certain situations. If you are using a camera with interchangeable backs, such as a Hasselblad, you have the option of labeling one back Normal, another N + 1, and so on. This will allow you to switch backs as the situation demands. Eventually you will find that your awareness of the importance of subject contrast will make you very sensitive to changes in the light. Roll-film cameras are designed to make bracketing very simple. If you take advantage of this and pay attention to how the contrast changes from one moment to another, you will gradually develop instincts that will make adapting to this situation much less of a problem. Another alternative is self-rolling very short rolls of film with the intention of shooting one roll per subject. If this is done carefully (dust in the bulk loader's gate can be a serious problem), it will work and save you money. In the long run it is probably better to "waste" the extra frames on a normal roll of film. (I put the word waste in quotes because often your best shots will be on those extra frames.)

Q: Can the Zone System be used with color film?

A: In general the answer is yes, and in many ways certain inherent characteristics and limitations of color films make the Zone System an even more important tool.

The rules of exposure apply as much to color film as they do to black-and-white film. On the other hand, color materials present you with special problems of which you should be aware. First, the range of subject contrast that can be recorded on color reversal films (otherwise known as chrome, transparency, or slide films) is relatively narrow when compared with color negative or black-and-white films. The effective range of detail in a properly exposed and processed color negative can be between Zones II and VIII. With transparency films the range is between Zones III and VII. Slide films are very intolerant of exposure errors (they have limited exposure latitude).

If your exposure is more than one-third of a stop under the correct placement of Zone III, the whole image will be too dark. This means that in general you will get better results using color-slide film in situations where the contrast is not too great; indoors with flash or outdoors on slightly overcast days, for example. The accuracy and reliability of the Zone System of exposure can be of great advantage when you are shooting color films.

The second problem is that if color film is given more or less development than the amount predetermined by the manufacturer, you run the risk of getting inaccurate color in the resulting slide or negative. Overdevelopment causes the images to look warmer (more red); underdevelopment results in cooler pictures (more blue). This shift in color balance can be corrected to some degree when color negatives are printed.

Underdevelopment also causes the black areas of color slides or prints from color negatives to be "incomplete," meaning that the black areas will be rendered as a muddy dark gray with a noticeable colorcast. One result of this effect is that there is no simple way to control the contrast of color films without affecting the color rendition. This means that you may have to adapt the way that you expose color film when subject contrast is greater than the effective range of the material you are using.

For example, if you are shooting a very contrasty subject, a snow scene with dark foliage for instance, you may have to expose for the highlights and allow the shadows to fall where they will. This could mean metering the snow and placing the reading on Zone VII or VIII for color negatives or Zone VII for color-slide films. The foliage will probably print as relatively dark silhouettes, but the overall impression of the image should be acceptable. If possible, you could use an electronic flash to add more light to the darker areas.

Color negative films are self-masking, which means that the density of the highlight areas is restrained as they develop. This essentially allows the shadows to "catch up," giving you relatively more detailed dark areas without blocked-up whites. Color negative films can be overexposed by as much as three stops and underexposed by one stop, and the negatives will still be printable. Color-slide films don't have these advantages. Because of this and their more narrow contrast range, color transparency films require more careful control.

One major advantage of understanding and using the Zone System is that it gives you a reliable way of measuring subject contrast and exposing accordingly.

In commercial studio and location photography, it is often necessary to use longer or shorter development times to make small, precise corrections of the overall density and contrast of your negative or chrome. Usually Polaroid materials are used to proof setups. Contrast and exposure manipulation is done with extra lights or reflecting fill-cards. If more corrections are needed, many of the better color labs will custom process color films if you know the practical limits of the materials and how to explain what you want to the technicians.

To color labs, pushing and pulling film means, respectively, increasing and decreasing the development time. Instead of "zones," they are more accustomed to speaking in terms of "stops." Thus "pull this film one stop" means "please reduce the development time of this roll by enough to give me one zone's worth of Contraction."

The following is a list of some color films and the amount of contrast control you can ask a lab to give you and still get acceptable results. N.R. means "Not Recommended."

FILM	ASA	PUSHING LATITUDE	PULLING LATITUDE
Kodak Elite Chrome	100	3 STOPS	N.R.
Kodak Elite Chrome	200	3 STOPS	N.R.
Kodak Elite Chrome	400	3 STOPS	N.R.
Kodachrome 64		1 STOP	1 STOP
Ektachrome P1600		2 STOPS	1 STOP
Fujichrome Velvia 50		1 STOP	1 STOP
Fujichrome Provia	100	2 STOPS	1 STOP
Fugicolor Super HG	1600	2 STOPS	N.R.

Because of the color shift problems described above, Kodak doesn't recommend push or pull processing for any of its Gold, Gold Max, or Royal Gold color negative films.

Q: What problems will I encounter if I can't use a spot meter?

A: As you have seen in the previous chapters, a spot meter's ability to read small, isolated areas from a distance makes it the perfect tool for using the Zone System. On the other hand, you can achieve reliable results from any meter if you know how to use it properly.

A wide-angle meter will give you an accurate reading of any area if you get close enough to the metered area and are careful not to include unwanted objects in the meter's field of view.

A built-in meter, aside from being wide-angle, has two other features you should be aware of. The first is that built-in meters are very often "center-weighted," which means that they are designed to be more sensitive in the center of the frame than at the edges. Second, built-in meters are sometimes calibrated to place their meter readings on Zone VI instead of Zone V. The reason for these idiosyncrasies is that the camera manufacturer is making two assumptions. First, they are assuming that you are going to put your friends or relatives in the center of the frame. Second, the company is assuming that the subjects are Caucasian. Remember that Zone VI is the average zone for light skin.

If you are going to try using an in-camera meter in the ways described in this book, you will have to take these factors into consideration. For example, if you fill the frame of the camera with the area you are trying to meter, the fact that the meter is center-weighted will not matter. If you are metering a model's hair, this means getting close enough so that all you can see through the viewfinder is her hair. If you then center the needle or dot by adjusting the f/stop or shutter speed, you will have placed her hair

on Zone VI if this is the way your meter is calibrated. (You can check your meter's calibration by comparing your readings to those of a hand-held meter or having it checked by a camera repair shop.) Let's say that the exposure the meter recommends is f/8 at 1/30 of a second. If you were to stop down three stops from this exposure, you would then have the correct Zone III exposure for her hair, f/22 at 1/30 of a second.

To measure the overall contrast of the subject, you will have to fill the frame with the Important Highlight Area, center the needle, and make note of how many stops difference there is between the shadow reading and the highlight. If the meter recommends an exposure of f/1.4 at 1/30 when you meter the shadow area and f/5.6 at 1/30 when you meter the highlight, you know that there is a four-stop difference between the two areas. Obviously, this system will work, but at best it is complex and cumbersome. If you find yourself having to do this very often, you would probably be better off investing in a decent spot meter. The 35 mm camera is a specialized tool that is designed to be quick and easy to use. With practice and an awareness of how the in-camera meter is designed, it won't take you long to develop working methods that are efficient for your shooting habits. Often you will see experienced 35 mm photographers taking a meter reading from their own hands before shooting. By metering a flesh tone and making use of the meter's automatic Zone VI placement, they are using a derivative of the Zone System.

Q: How does the Zone System apply to the use of electronic flash?

A: In general, the correct exposure with electronic-flash units is calculated by carefully measuring the camera-to-subject distance with the range-finder on the lens and using this to select the proper f/stop with the exposure dial on the flash. You must use the shutter speed that is synchronized with your flash, usually 1/60 or 1/125 of a second (check your owner's manual). As noted in an earlier chapter, with modern electronic-flash units, the exposure is determined by a thyristor circuit that controls the output of the flash. Dedicated flash units automatically adjust both the f/stop and shutter speed of the camera.

The Zone System allows you to accurately measure the contrast of your subject. If you determine that the contrast is too great, you have two choices: You can base your exposure on the shadow areas and reduce the contrast of your negative by decreasing the negative's development time, or you can expose for the highlights and add more light to the shadow areas with fill-flash. This usually involves setting the flash to 1/2, 1/4, or 1/8 power depending on how much fill you need. The instructions provided with your flash will explain how this is done. The second procedure is especially useful in back-lighting situations with both black-and-white and color films.

In a photographic lighting studio where you are essentially starting with a "blank canvas," the art of previsualizing becomes an extremely important part of the overall creative process. Ordinarily studio photographers use powerful electronic strobe units with power packs to light their subjects. The lighting composition is done with built-in modeling lights that are much less bright than the flash itself. Because the bursts of light from the flash heads are extremely short, special flash meters are required to measure the incident light and provide an exposure. Since the shutter speed is fixed and synchronized with strobe, flash meters provide their readings as an aperture number. The brighter the light the

smaller the aperture. It is very common for studio photographers to use Polaroid film to help them previsualize their lighting and to help calculate the exposure.

Contemporary spot-flash meters now allow you to take reflected strobe readings of the key areas of your subject. This makes the application of Zone System concepts in the studio a straightforward process. By carefully measuring the contrast of your subject you can previsualize your image and determine how much extra light to add with fill-cards or lights. Once the contrast has been balanced and adjusted your film is usually given Normal Development.

Q: How can I override my camera's automatic metering system?

A: As we discussed earlier, most built-in light meters are designed to operate "automatically," which means that when you adjust one of the exposure controls, the meter will internally adjust the other to maintain its recommended Zone V exposure. There are two types of built-in meters.

Aperture-priority meters allow you to choose the aperture you prefer and the meter will adjust the shutter speed.

Shutter-priority meters allow you to choose the shutter speed you prefer, and the meter will adjust the aperture.

To use an exposure other than the one recommended by the meter, you will have to override these automatic functions using one of the following methods, depending on how your camera is designed (check your owner's manual).

Manual Setting. If your camera has a manual mode, you can set both the aperture and shutter speed to the exposure of your choice. For example, if the meter recommends an exposure of f/11 at 1/30 for an area you wish to print as Zone III, you can simply change your setting to either f/22 at 1/30, or f/11 at 1/125. These exposures are equivalent and are both two stops darker than the meter's recommended setting (Zone V).

Exposure Compensation Dial. This function allows you to change the meter's recommended exposure by up to three stops darker (−1, −2, −3), or one to three stops lighter (+1, +2, +3). Some cameras use (x1/2, x1/4) for darker exposures and (x2, x4) for lighter exposures. Refer to Appendix P if the use of these exposure factors is not clear.

Memory Lock. This function allows you to take a meter reading of a given area of the scene, lock that recommended exposure into the meter, step back, and use this exposure for the whole picture. Because the meter's recommended exposure is Zone V, this means finding a part of the subject that you previsualize as middle gray in the final print and locking in the recommended exposure for that area. Some photographers carry a Neutral Gray Card with them to use in situations like this. A variation on this procedure would be to meter an area you previsualize as Zone III and stop down two stops from the meter's recommended exposure.

Film Speed Adjustment. If your camera has no other way of overriding its automatic function, it is usually possible to change the meter's recommended exposure by

resetting the ISO/ASA. Remember that when ASA numbers double (for example, from ASA 400 to 800), the amount of exposure requires halves. Halving your ASA setting will increase the exposure by one stop. Review "Measuring Zones," page 31, Chapter 4. For example, imagine that you are metering a wall and your camera recommends f/16 at 1/60 for a film rated ASA 400. That exposure would render the wall Zone V. To place the wall on Zone IV, change the ASA from 400 to 800. The recommended exposure would then be f/22 at 1/60 or equivalent. To place the wall on Zone VI, change the ASA from 400 to 200. The recommended exposure would then be f/11 at 1/60 or equivalent. Remember to reset the ASA to your normal speed for that film after taking the picture.

There are cameras with DX code-reading systems that automatically set the ASA for you, and there are some "fully automatic" cameras that do not allow you to override the metering system. The Zone System can't be effectively used with these cameras.

Q: What role do ASAs play in applying the Zone System to my photography?

A: Most photographers think of ASA as simply a rating of a given film's sensitivity. This is true as far as it goes, but there is more to it than that. Earlier I said that ASA numbers can be related to f/stops and shutter speeds in the following way: As the ASA number gets smaller, the amount of exposure needed increases. Keeping in mind that the amount of exposure determines the negative's shadow density, we can state the above rule in another way: The lower the ASA number you use for a given film, the more density and detail you will get in the shadow areas of your negatives and prints.

Taking this into account, you can see that the important question is what ASA should I use with my film to get the best shadow detail? Many photographers have discovered from experience that the manufacturer's recommended ASA doesn't give them the amount of shadow detail they need in their work. In other words, after carefully placing a shadow reading on Zone III using ASA 400, you may find that the negative is underexposed by one stop (Zone II). This is not because the placement is incorrect, but rather because the photographer overestimated the speed of the film. The remedy is to shoot the film at ASA 200 instead. This would give the film one stop more exposure every time and guarantee that Zone III will always print with the detail you expect.

There are, of course, many situations where you need to use a higher ASA than the manufacturer recommends. This is called pushing the film, and it is often necessary in low-light situations. Do this with films that are relatively fast, such as Kodak Tri-X or Ilford HP-5+. Faster films generally have more exposure latitude than slower films. The only way to determine what ASA will suit your needs is to test your film and developer.

I should make one last point about the effect of changing a film's ASA. Using a lower ASA will improve your shadow detail, but it will also add density to the highlight areas of the negative. To compensate for this, you must establish a Normal Development Time that is shorter than the manufacturer recommends. The reverse is also true. If you push the ASA of a film, you must increase the film's Normal Development Time.

Q: Will digital photography make the Zone System obsolete?

A: The answers are no and yes. Digital imaging techniques have changed our approaches to photography in ways that we are just beginning to comprehend. For many years it has been possible to digitally manipulate images designed for reproduction with methods so convincing that our notions of "photographic realism" no longer have conventional meanings. As profound as these changes have been, they have had relatively little effect on photographers committed to the aesthetics of the classic "fine print." The dream of many photo-artists has been that computers would provide an easy alternative to the labor-intensive multiple printing techniques perfected by Jerry Uelsmann, among others. But until recently there has been no way to use digital technology to produce manipulated continuous-toned photographic prints.

As of this edition of this book, all of this has changed. Both ink-jet printers and digital cameras have improved to the point that it is now possible to produce exquisite photographic images that are completely satisfying as fine prints. This is why we are now in the midst of what can fairly be called a revolution that rivals the emergence of the roll-film cameras years ago. Photographic film, paper, and chemistry manufacturers who fail to respond to these changes will soon disappear and many photographers find themselves grappling with adapting to a very different set of aesthetic and technical assumptions.

On the other hand, it is not a question of digital processes precisely replacing the qualities of fine silver prints. There will always be distinctions that will be important to specialists. Digital processes offer the opportunity to produce work that has extraordinary qualities that, while different from silver-based work, is fully resolved in its own terms. The formal and aesthetic equivalency of oil painting to pastels is a good example. It's simply impossible to imagine the world of fine art without one or the other. What will most likely happen is that silver-based photography will become a specialized practice reserved for those devoted to its qualities. This seems inevitable given the proliferation of digital cameras in both the amateur and professional markets.

What distinguishes digital photography is its ability to render fine prints on a vast array of paper surfaces and the fact that pixel editing software allows photographers to move relatively easily from the realms of objective, documentary-related ways of shooting, to the open, abstract, and complex layered image-making modes typical of collage/montage artworks.

But for all of the potential benefits of digital photographic processes, the transition requires a detailed understanding of radically new technologies. The fact that the Zone System has a great deal to offer photographers considering this transition is the premise behind the extensive digital chapter (Chapter 10) that has been added to this edition. You will find that it covers all of the issues related to this process in great detail.

Q: How do I know what the Normal Development Time is for the film and developer I use?

A: Film and developer manufacturers routinely recommend a range of standard development times for their products. These are useful as starting points, but you can't depend

on them for reliable results. The problem is that the correct Normal Development Time for your needs depends on a number of variables, including the following:

1. The ASA you use.
2. The rate of agitation you use while developing the film.
3. The dilution and temperature of the developer.
4. The grade of paper you routinely use.
5. Whether you use a condenser- or diffusion-type enlarger (see Appendix M).
6. The pH of the water in your area.

Even if you try to follow the manufacturer's instructions exactly, your times could still be different than those they recommend. The only way to determine the Normal, Expansion, and Contraction development times that are correct for your photography is to do a test with your camera and meter that takes all these factors into consideration. The following two chapters outline two testing methods for this purpose.

CHAPTER 8

Zone System Testing: Method 1

Introduction

In the hands of serious photographers, the Zone System can be a powerful, creative tool. Zone System testing is important because it provides you with valuable information and demonstrates that your camera, film, and light meter can work together in a direct and systematic way.

Unfortunately, my experience has been that some students become frustrated and give up in their efforts to master the system when confronted with the need to test their equipment and film. The problem is that most testing procedures are too abstract or complex to be practical. Of course, a certain amount of discipline and persistence are required to complete any test, but photographing gray cards under floodlights or plotting curves on graphs is only going to excite photographers who enjoy working scientifically. Most of us would rather just take what we have learned directly into the world and begin using it.

The main difference between the testing method outlined in this chapter and others is that it allows you to work directly with all the problems and variables you will encounter in your work. In one sense, this makes the test more difficult. In a studio, you don't have to worry about clouds, changing light, or all the other factors that are so much a part of photography in the real world. The advantage of this approach is that a test of this kind saves you from having to do one test in the studio and another in the field to see whether your laboratory results really work. For a photographer with the necessary time and patience, a test of this sort will yield a wealth of information and confidence. The finished print will be tangible proof of your ability to control exposure and development.

This book offers two approaches to Zone System testing. In different ways each method allows you to begin applying the Zone System to real-life shooting situations right away. Method 1, in this chapter, is adapted from a number of the more classic methods outlined in other works on this subject. This test is designed to give you the maximum amount of information with the minimum amount of time and film. Zone System testing Method 2 in the next chapter is designed for experienced photographers who would like reliable guidelines as starting points for determining their personal working ASA, Normal Development, Expansion, and Contraction times.

Whichever method you use, it is important that you read the procedure through completely and make sure that you understand it before you start. It is also a good idea to work through this test with a friend to help you record and organize the steps.

Appendix R, the Zone System Testing Checklist and Exposure Record, will help you keep track of your procedure and record your results. Instructions for sheet-film users are enclosed in boxes. Make as many copies of the Exposure Record as you will need for each test you do.

Having done this test with dozens of students, I can confidently say that your results should be within predictable limits. (See the development charts for Method 2 in Chapter 9.) In a sense, you aren't really testing the materials so much as your ability to make your equipment, film, and processing procedures respond as they should.

If you finish Method 1 with unreasonable results (for example, ASA 1000 or 50 for Tri-X), you have definitely done something wrong. If this happens, review each step carefully until you are sure you understand where the problem is, then start again.

Instructions are included for testing both roll and sheet film. The results from these tests will apply only to films with ASA ratings equal to the film you are testing. Method 2 lists a number of different films and the results obtained from testing them for Normal, Normal Plus, and Normal Minus times. Using these charts as a reference, it is possible to extrapolate the results from one film to another with a different ASA, but this requires a great deal of experience. In general, I would recommend that new Zone System users retest when they change films or developers.

Choosing a Photographic Paper

Although paper grade or variable contrast filter 2 is standard for Normal contrast negatives, experienced photographers know that every brand and grade of paper has unique characteristics. One of the objects of Zone System testing is to match the contrast of your negatives to your favorite type and grade of printing paper. Having standardized your normal printing, you can use the higher and lower paper grades when extreme Expansions or Contractions are required to compensate for very low or high contrast subjects.

For those who have not decided what paper to use for this test, I recommend that you begin researching the range of different paper surfaces and tones that are available by comparing the paper sample books available at most photographic supply stores.

No one brand or type of paper is ideal for all uses, but in general, the more expensive graded or variable contrast fiber-based papers are preferred for exhibition-quality printing. Resin-coated papers are ideal for volume production printing because they process much more quickly and require much less washing and drying.

> **Note: In a previous edition of this book I wrote, "…in general, resin-coated papers aren't recommended for exhibition-quality work because they haven't been proven to be archival." But then my favorite Kodak representative pointed out to me that the same resins are used for both RC papers and the bases of Kodak films. Color printing papers are also all resin-coated.**

An important factor to consider when choosing a personal Normal grade of paper is the light source of your enlarger. Condenser enlarging light is inherently more contrasty than light from cold-light or diffusion enlargers. This means that you will generally use lower paper grades when printing with condenser enlargers. For more information on this factor see Appendix M.

The Use of Equivalent ASA Numbers

Testing Method 1 is designed to allow you to test your film at a wide range of ASA numbers on the same roll or box of film. In this way, you will determine which ASA is best for your purposes. To do this, you are going to bracket your exposures on each roll according to a predetermined plan. The principle that governs this process is very simple.

Bracketing your exposures is the same as changing the ASA on your meter. Consider this demonstration:

1. Set your light meter to ASA 400 and place meter number 12 opposite the Zone V arrow. If you were testing Tri-X, normally rated ASA 400, and had placed meter number 10 on Zone III, your first exposure would be f/16 at 1/60 of a second (Figure 58).

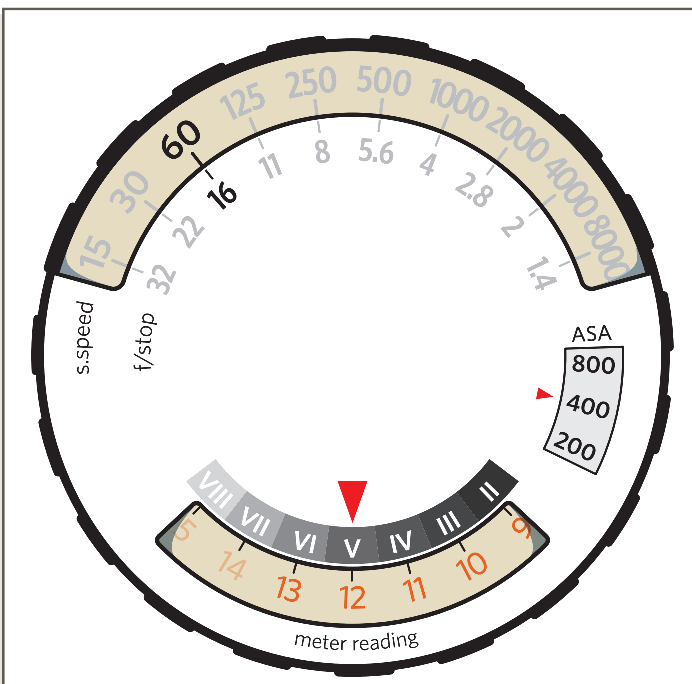


FIGURE 58 Zone III placement of meter number 10 at ASA 400. Exposure: f/16 at 1/60 of a second.

2. Stop down one-half stop from this starting point without changing your ASA. Your exposure is now 1/60 of a second at f/16-22 (Figure 59).

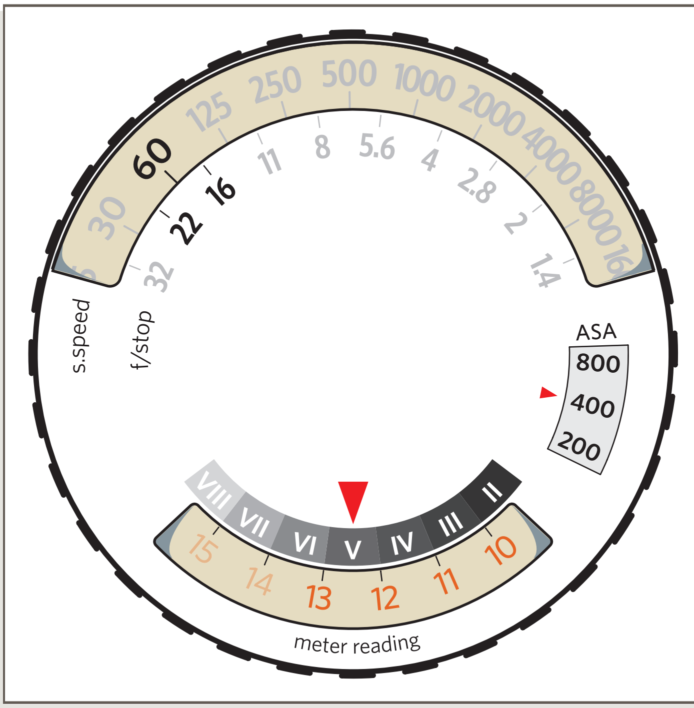


FIGURE 59 One-half stop less exposure at ASA 400. Exposure: f/16-22 at 1/60 of a second.

3. If instead of stopping down, you were to reset your ASA to 600 without changing your placement of meter number 10 on Zone III, the result would also be 1/60 of a second at f/16-22 (Figure 60).

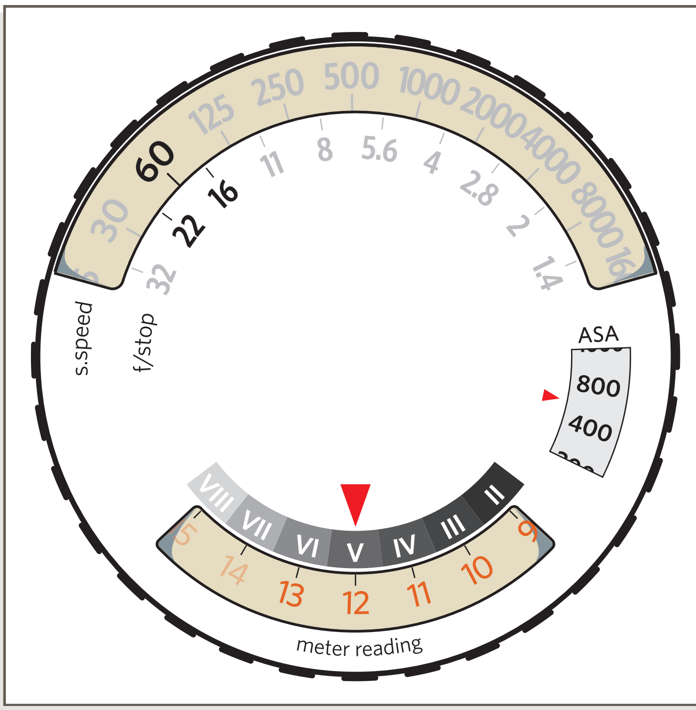


FIGURE 60 Zone III placement of meter number 10 at ASA 600 (between ASA 800 and 400). Exposure: 1/60 of a second at f/16-22.

These examples demonstrate that after you have established your placement of the Important Shadow Area, stopping down has the same effect as shooting at a higher ASA number. As far as the film is concerned, there is no difference. Of course, this principle also operates in the other direction: Opening up is the same as using a lower ASA number.

In testing Method 1, you will be filling in a column on the Exposure Record labeled "ASA" (column C in Figure 62). The ASA numbers that you enter in this column will be the ASA numbers that are equivalent to the exposures in the adjacent columns. For example, Figure 60 shows that ASA 600 is equivalent to stopping down one-half stop from f/16 at 1/60 of a second at ASA 400. At no point in the test should you change the ASA setting on the dial of your meter. Set your ASA dial to the number recommended by the manufacturer, then stop down or open up as indicated by the exposure plan that is appropriate for your film format. After you have calculated and entered your exposures on the Exposure Record, enter the equivalent ASA numbers in the column to the right.

This process will be reviewed here, but it may be useful for you to work with this concept using your meter dial until it is clear.

Zone System Testing: Method 1

This test has three objectives:

1. To establish a personal working ASA (also called your Exposure Index, or EI) for whatever film and developer you decide to use. What you are trying to find is the highest ASA for your film that will give the best shadow detail in your negatives and prints. The result of this test may be a different ASA than the manufacturer recommends, but once it is established, it will be a standard you can depend on for good results.
2. To determine your Normal Development Time. This is the time you will use for subjects with Normal contrast. It will also be the basis for your Expansion and Contraction development times.
3. To determine a standard printing time. Whenever you make a print, there is a minimum amount of exposure under the enlarger at a given f/stop that will make the clearest part of the negative (Zone 0) as black as it can get. Let's say this exposure time is twenty-two seconds. If twenty-two seconds is truly the minimum time it takes to make the film base as black as it will print, then twenty-four seconds (or for that matter five hundred seconds) will not make Zone 0 any darker. What the extra exposure would do is make all the other tones in the print darker. Any less exposure will not be enough to give you a true black anywhere in the print.

A simple test outlined in this chapter will determine your minimum time for maximum black exposure, which you will use as a standard for the test. Because this time will change when the enlarger is focused higher or lower, you must also choose a standard image size. Your test results will apply regardless of what size print you decide to make in the future.

For this test, you will need the following materials:

1. A camera, tripod, and cable release. Test your camera for light leaks and shutter accuracy before you start.
2. A reflected-light meter. A spot meter is preferable because it is easier to get an accurate and consistent reading. Whatever light meter you use, be sure that it is accurate or that you know how to compensate for it if it isn't. See Appendix P.
3. Film. I have included instructions for testing both sheet and roll film. If you are doing this test with roll film, you will need four rolls of your favorite film. For sheet-film testing, you will need twenty-four sheets. After you have loaded your twelve film holders, divide them into four sets with three holders (each containing two sheets) in each set, and label them A, B, C, and D. Number each set from 1 to 6. This will give you four number 1 sheets (1A, 1B, 1C, 1D), four number 2 sheets, and so on.

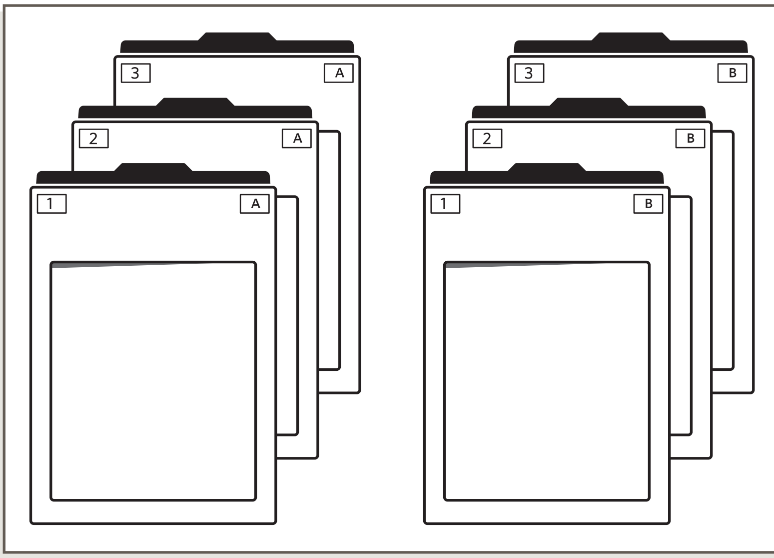


FIGURE 61 Sheet-film holder arrangement. Sets C and D are not shown.

4. Developer. You will need enough of your favorite developer to process the film required. Be sure you dilute the developer and control the temperature very carefully. It is important that the temperatures of the developer, stop bath, and fixer are all the same. For more information about developers and films, consult Appendixes E and G and testing Method 2.
5. Photographic paper. Use a normal grade of paper. Grade 2 is normal for most brands. Check the manufacturer's information sheet if you aren't sure. If you prefer a particular type or grade of paper, you can use it if you keep in mind that this will become your standard paper for as long as you use the same film and developer. (See Appendix M for information on the role different enlarging light sources play in choosing a Normal grade of paper).
6. A Neutral Gray Card. This will provide a visual reference in the printing part of this test.
7. If you are testing sheet film, you will also need a large note pad and marker.
8. Select an appropriate test subject. For reasons discussed earlier, you should do this test outdoors or under your normal working conditions. A light-colored house makes an ideal subject because it is usually easy to meter a full range of zones, from Zones II and III for dark shrubs or woodwork to Zones VII and VIII for the house itself. If it is a clear day or slightly overcast, the contrast will remain constant for a reasonable amount of time. On partly cloudy days, the light is too unstable. If you choose not to use a house, any subject that gives you a full range of zones will do.

Whatever subject you choose, it is important that you have clearly visible and logical areas of Zones II, III, and VII. I emphasize the word "logical" because in the end, it is your judgment of the final print that will determine the results of this test. The goal is to end up with a beautiful,

full-toned rendering of the test subject. If you keep careful records of how you make this print (the ASA, placement, and development time), you will have established these as standards for future use.

Careless previsualization can throw off the whole process. For example, if you choose the darkest part of the subject (logically Zone I) as your Important Shadow Area, you might succeed in rendering that area as Zone III in your print, but your negative will be overexposed by two stops, and this will give you misleading results.

It is also important that the subject you choose has Normal contrast. If the test subject is too flat or too contrasty, it will confuse you unnecessarily. Many of my students are casual at this point and it ruins their results. The time you spend finding the perfect subject will be well worth it in the end.

Begin by making a simple form like the one in Figure 62 or make an enlarged copy of the Exposure Record on page 230. Use a copy of the checklist on pages 231–232 to keep track of your progress.

FILM: ____________

	ZONES										A	B	C	
SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

FIGURE 62 Exposure Record.

Step 1

Assuming that you are using a house for this test, make a simple sketch of it above your form (Figure 63). It doesn't have to be detailed as long as it outlines all the important areas you are reading.

FILM: ____________________

	ZONES										A	B	C	
SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

FIGURE 63 Step 1 – Sketch and Exposure Record.

Step 2

Carefully meter all the important shadow, middle, and highlight areas of the house, and write the meter numbers on the sketch (Figure 64). Try to record as many numbers as you can. You will have to check these readings often throughout this test to make sure they don't change. Again, make sure your subject has prominent areas of Zones II, III, V, and VII (and Zone VIII if possible).

FILM: ____________________

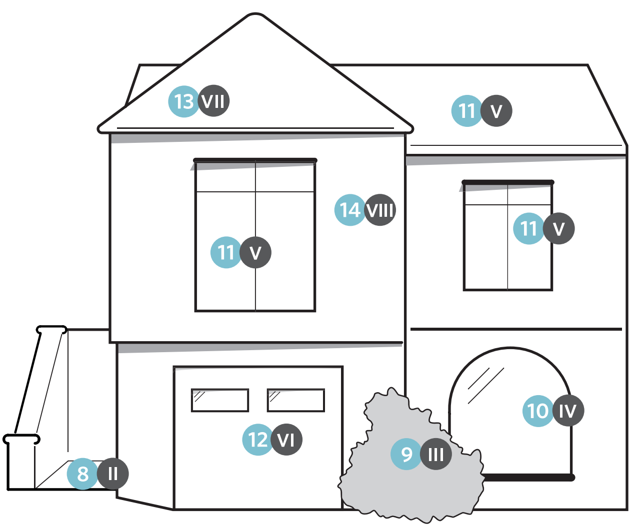
					ZONES						A	B	C	
SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

FIGURE 64 Step 2 – Sketch with EV meter readings.

Step 3

Place the meter readings from the house on the Zone Scale according to your previsualization (Figure 65).

Remember that one of the primary objectives of this test is to determine your Normal Development Time. For this reason, it is very important that your placements be logical and that all the values fit properly on the scale. For example, a common mistake would be to place the meter reading for the very dark part of the subject on Zone III instead of Zone II. This would result in a print that looks one stop lighter in the shadow areas than you would expect. Zone III is the appropriate zone for well-lit, fully textured, dark subject areas such as green foliage and brown wooden doors. Also, if the contrast of your test subject is too flat or too contrasty — in other words, if the Important Highlight Area falls on Zone VI or VIII instead of Zone VII — find a better house.



FILM: TRI-X

					ZONES						A	B	C	
SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1 TEST HOUSE			8	9	10	11	12	13	14					
2														
3														
4														
5														
6														
7														
8														
9														
10														

FIGURE 65 Step 3 – Sketch and Exposure Record with placements.

Note: **Don't be surprised if all your meter readings don't fit as perfectly on your Zone Scale as they do on my ideal illustration. If, for example, after placing your Important Shadow Area on Zone III, the area that you wanted to be Zone VI falls on Zone VI 1/2, simply record this on the Exposure Record and take this into consideration when you evaluate your final test print. What is important is that you have clearly visible areas of Zones II, III, and VII.**

Step 4

Set up your camera and put the Neutral Gray Card in the picture in a place where it reads Zone V. Remember that although the card itself is Zone V, if it is put in a dark area of the scene, it could all on Zone III or IV. Keep moving it around until its meter reading falls on Zone V.

Step 5

Calculate your exposures and fill in the blank spaces of your Exposure Record using the following procedure. You will expose the first frame of your test roll or the number 1 sheets of your four sets of film using the manufacturer's recommended ASA. The exposures of the remaining frames will be bracketed by half stops for one or two full stops in both directions from this starting point. As explained in the introduction, bracketing exposures has the same effect as changing the ASA.

Under column A, labeled "S Speed," list the shutter speed chosen for your test exposures. For greater accuracy, it is important that you bracket using the f/stops rather than the shutter speeds. Choose a shutter speed that allows you a two-stop range of apertures on either side of the starting point for roll-film tests and one stop above and below for sheet film.

Under column B, labeled "F/Stop," list the apertures of your test exposures using the formulas listed below. Use plan A for roll-film tests and plan B for sheet-film tests.

Note: **You will expose the first frames of your test rolls and sheets using the aperture recommended when the meter is set at the standard ASA for the film used. Thereafter, you will adjust your exposure by half stops in both directions from this starting point without changing the ASA on the meter's dial. Only the aperture should be changed during these test exposures.**

Exposure Plan A For Roll Film

Expose your test rolls as follows:

FRAME	APERTURE SETTING
1	Normal exposure at the film's standard ASA
2	One-half stop less exposure than frame 1
3	One full stop less exposure than frame 1
4	One and one-half stops less exposure than frame 1
5	Two full stops less exposure than frame 1
6	Same exposure as frame 1
7	One-half stop more exposure than frame 1
8	One full stop more exposure than frame 1
9	One and one-half stops more exposure than frame 1
10	Two full stops more exposure than frame 1
11	Blank
To end	One full stop more exposure than frame 1

Exposure Plan B for Sheet Film

Expose the sheets labeled 1–5 of sets A, B, C, and D as follows:

SHEET	APERTURE SETTING
1 (A, B, C, D)	Normal exposure at the film's standard ASA
2 (A, B, C, D)	One-half stop less exposure than sheet 1
3 (A, B, C, D)	One full stop less exposure than sheet 1
4 (A, B, C, D)	One-half stop more exposure than sheet 1
5 (A, B, C, D)	One full stop more exposure than sheet 1

Under column C, labeled "ASA," list the equivalent ASA numbers for the exposures listed in columns A and B.

Note: Modern light meters list ASA numbers that double from 6 through 6400, with one-third-stop markings in between. For the purposes of this test, we are bracketing by half stops. Use equivalent ASA numbers that are halfway between these printed numbers. For example, between ASA 400 and ASA 200 would be ASA 300 or 250. The actual number you use doesn't matter as much as consistency. Of course, your meter numbers and exposures will probably be different, but at this point, your Exposure Record and sketch should be similar to Figure 66. Study this illustration carefully. It is important that the logic of these settings is clear.

FILM: TRI-X

		ZONES										A	B	C	
	SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1	TEST HOUSE			8	9	10	11	12	13	14		1/125	F/8	400	NORMAL
2	"											"	F/8-11	600	
3	"											"	F/11	800	
4	"											"	F/11-16	1000	
5	"											"	F/16	1600	
6	"											"	F/8	400	
7	"											"	F/8-5.6	300	
8	"											"	F/5.6	200	
9	"											"	F/5.6-4	150	
10	"											"	F/4	100	
11	UNEXPOSED														
12	REMAINING FRAMES											1/125	F/5.6	200	

FIGURE 66 Step 5 – Sketch and Exposure Record filled in completely.

Step 6

Recheck the key meter readings of your test subject to make sure the light hasn't changed. (It will take you much less time to actually meter your subject and fill in the Exposure Record than it took you to read through the previous step.)

Roll Film

Step 7

Expose the first roll of film using the exposures listed on the Exposure Record. Use your lens cap for the blank frame on each roll. The remaining frames are exposed to keep the number of exposed frames being developed consistent with your usual procedures.

Expose the remaining three rolls exactly the same way, making sure the light hasn't changed between rolls or exposures.

Sheet Film

Using the exposures listed on the Exposure Record, expose the four sets of film holders according to the following procedure. This will ensure that the exposures of all four sets are identical. It will also help you identify each sheet for future reference.

a. Put your large pad in the test area in a clearly visible place. The writing on this pad will be easier to read in the test prints if you avoid putting it in a brightly lit area of the scene.
b. In large letters, write "1A" on the pad, then expose sheet 1 of set A as listed on your Exposure Record.
c. Write "1B" on the notepad and then expose sheet 1 of set B using the same exposure you used for sheet 1A. Label sheet 1 of sets C and D on the note pad and give them the same exposure.
d. After stopping down one-half stop as listed on the Exposure Record, label and expose sheet 2 of sets A, B, C, and D.
e. Follow the same procedure to expose and label the rest of the sheets in each set.

Step 8

After you have exposed all your film, develop one roll or one complete set of sheet film (1A–5A plus one sheet of unexposed film) using your favorite developer. If you have a Normal Development Time you are comfortable with, use it. If not, use a time I recommend in testing Method 2 in Chapter 9 or refer to the fact sheet that came with the developer. Use the minimum time recommended for your film. Process and dry your film normally.

Standard Printing Time Test

Step 9

To determine the minimum time it takes to achieve the maximum black, perform the standard printing time (SPT) test as follows:

1. Using one of your test exposures, focus your enlarger at the printing size that is normal for your work.
2. Place the blank sheet of film in the negative carrier so the unexposed film covers one-half of the opening. To do this with roll film, you must cut the blank frame in half. Your negative carrier should look like this:
3. Put the negative carrier in the enlarger and make a series of test exposures on a full sheet of normal paper at two-second intervals. Use an f/stop that is in the

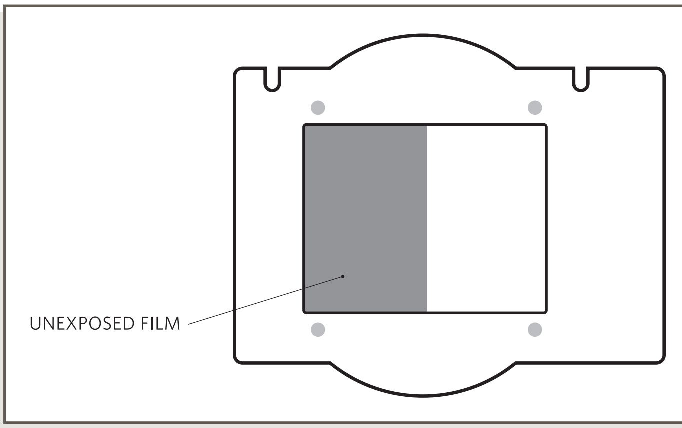


FIGURE 67 Negative carrier with film base.

middle of your enlarger's range and try to get as many exposures on the test sheet as possible.

4. Develop the print for two to three minutes in your normal print developer. When this print is processed and dried it should look like Figure 68.

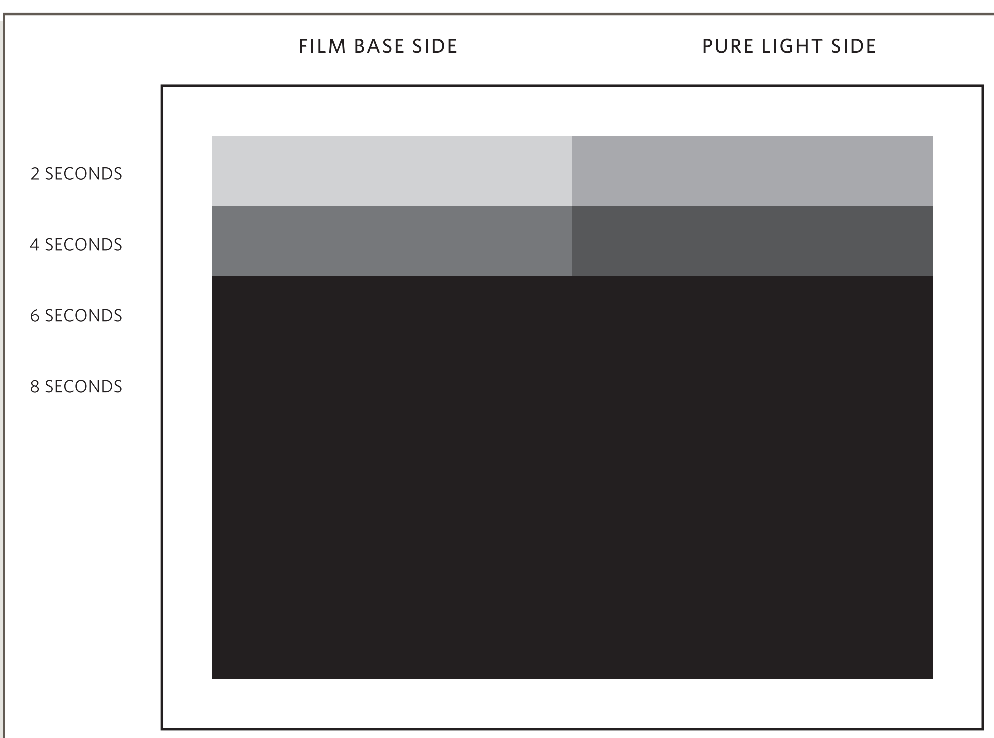


FIGURE 68 Test print.

If the division between the two halves of this print doesn't disappear somewhere along the sheet, you haven't reached the paper's maximum black exposure time. Open up one stop and make another set of exposures.

Note: You may notice a very faint line between the two halves of this print. Just ignore this. It is important that your test print be dry before you go on to the next step. Most printing papers darken as they dry, and this will affect your judgment of which step is truly black.

5. Count the exposures on the film-base side of the print until you can no longer see the difference between one step and another. The first completely black step on the film-base side of the test print represents the exposure time you are looking for. If this step equals eight seconds' worth of exposure, your standard printing time is eight seconds at whatever f/stop the lens is set. Note this exposure for future use.

Step 10

Note: The steps on the "pure-light" side of the print should already be totally black. Use these for comparison.

Make one straight print of each test frame on a normal grade of paper using your new SPT. If you are testing roll film, remember to write the frame number on the back of each print. This number is the key to the ASA that was used to expose that frame.

Process and dry these prints before you judge them.

Step 11

If you are testing roll film, you should now have ten prints of the test subject. Sheet-film testers should have five test prints. Each print should be a little lighter or darker than the next because the prints represent exposures at different ASA numbers. Arrange these prints in the order that you exposed them. If you have done everything correctly, they should appear as follows:

Roll Film
Print 5 should be the darkest.
Print 7 should be lighter than print 1.
Print 9 should be the lightest.

Sheet Film
Print 3A should be the darkest.
Print 4A should be lighter than print lA.
Print 5A should be the lightest.

Step 12

The next step of this test is judging your test prints. Before you begin, it is important for you to know that it's very easy to choose an SPT that is slightly too long. This can be due to your timer being inaccurate or to the fact that printing papers don't always respond logically to accumulating

amounts of light. Five two-second exposures might not produce the same effect as one ten-second exposure. Choosing an SPT that is too long will cause you to choose an ASA that is too low. When you get to the point of selecting one print over another, keep this factor in mind. When in doubt, always try a slightly shorter SPT to print your key negative.

You can ignore the test prints that are obviously too light or dark, but two or perhaps three prints should have well-exposed shadow values. At this point, the shadow areas are the only parts of the print in which you are interested. (The highlights of these prints may be too gray or too white, but for now they are not important.)

Looking only at the darker parts of the image, choose the print that in your opinion has the best detail in the shadow areas. The Zone II areas of the print you select should be dark with a trace of detail. The Zone III areas should have good contrast and be fully detailed. Your sketch (Figure 65) will remind you of where these areas are. With this in mind, you should be able to narrow your choice to two prints. Remember that the goal of this test is to find the highest ASA that will give you the best shadow detail in the Zone II and III areas of your prints. If, for example, you are testing Tri-X and the prints representing ASA 300 and ASA 200 both appear to have good shadows, consider ASA 300 your choice. If the ASA 300 print has shadows that are a little too dark, make another print of this negative at a slightly shorter SPT and see whether it is acceptable.

If the shadows of the ASA 300 print are acceptable but the highlights are much too light, choose the ASA 200 print instead. The reason is that step 13 involves correcting the development time of your key negative. If the ASA 300 negative has good shadow detail but requires a reduction in the highlights, shortening the development time may reduce the shadow densities below a usable limit. If this is the case, the extra density in the shadow areas of the ASA 200 negative will give you a little leeway. Using this line of reasoning, you should be able to select the correct ASA for whatever film you are using. Having done this, you are now interested in only one key frame or one sheet of your test rolls or sets.

Don’t be surprised if the print you choose represents an ASA that is lower than the manufacturer recommends. This is very common. On the other hand, if you end up with an ASA that is unrealistically high or low (for example, ASA 150 or 600 for 400TX), you have probably made a mistake. Once again, the first thing to check is the SPT. Another common mistake is choosing an illogical area for Zone III. Consider your previsualization very carefully before you make your exposures. Placing the shadow on the wrong zone will throw off your judgment at this stage of the test.

Step 13

The last step of this test is judging the highlights of your key print. The procedure for this part of the test is to increase or decrease the development time of your duplicate test rolls or sets until you find the exact time that will allow your key frame to print well on a normal grade of paper. This will work only if the contrast of the test subject was Normal to begin with.

Refer to your sketch to see which areas fell on Zone VII. If the Zone VII areas of the print you selected for the best shadow values (again, refer to your sketch) are light gray and detailed to your satisfaction, then the amount of time you developed that negative is your new Normal Development Time. Congratulations! If the highlights of your key print are too dark, develop your second roll for 20 percent more time than you developed the first roll.

Note: **Increasing the development time will slightly increase the density of the negative's film base. For this reason, a slightly longer SPT may be needed to keep the shadows from printing too light. If an extreme increase in the development time is required, you may be able to move to the next higher ASA number.**

Sheet-film users should develop all six sheets of set B in spite of the fact that you are interested in only one key frame. It is important that you keep constant the number of sheets being developed in a given quantity of developer.

If the highlights of your test print are too white, develop set B or your second roll of film for 10 percent less time than the first set. Make a print of the key frame.

At this point, you should be very close to having a perfect print. If for some reason you're still not satisfied with your results, you still have two identical sets of test film with which to work. By continuing this process, you will eventually end up with a good print that will embody your new working ASA and Normal Development Time. These will apply whenever you use that combination of film and developer to make prints of any size.

Expansion and Contraction

Development Times

The following formulas will give you a shortcut method of computing your Normal Plus and Normal Minus Development times. A pocket calculator will make these computations very simple. Notice that special procedures are necessary to achieve good results with Expansions or Contractions of more than N + 2 or **N** − 2. Refer to Appendix H for more information on extreme Expansion and Contraction development and the use of compensating developers.

Note: **You will probably have to adjust the development times that you derive from these formulas as you go along. Keep careful records of your results.**

Standard Films

Normal Minus

To determine your Normal minus Development times, start with your new Normal Development Time and follow this procedure:

For your N − 1 time, multiple your new Normal time by 0.7.
For your **N** − 2 time, multiply your new Normal time by 0.6.

For example, if your new Normal Development Time is ten minutes, your **N −** 1 time would be seven minutes, and your N − 2 would be six minutes.

Normal Plus

To determine your Normal Plus Development times, the procedure is slightly different.

For your N + 1 time, multiply your new Normal time by 1.4.
For your N + 2 time, multiply your new N + 1 time by 1.4.

For example, if your new Normal Development Time is ten minutes, your N + 1 time would be fourteen minutes, and your N + 2 time would be 19 1/2 minutes.

T-Grain Films

Because T-Grain films are unusually responsive to changes in development time, the Expansion and Contraction formulas listed above don't apply to these films. When processing T-Max or Delta films in the standard dilutions of most developers, use the following formulas to compute your Normal Plus and Normal Minus times.

Normal Minus

To determine your Normal Minus Development times when using T-Grain films, start with your Normal time and apply the following formulas:

For your **N** − 1 time, multiply your Normal time by 0.9.
For your **N** − 2 time, multiply your Normal time by 0.8.

Normal Plus

To determine your Normal Plus Development times when using T-Grain films, apply the following formulas:

For your N + 1 time, multiply your Normal time by 1.1.
For your N + 2 time, multiply your N + 1 time by 1.1.

> **Note: The times you derive from these formulas should only be considered as starting points for determining the exact Expansion and Contraction times for your development procedures. Keep careful records of your results.**

CHAPTER 9

Zone System Testing: Method 2

The ever-increasing dominance of digital photography isn't the only unsettling development that photographers have had to cope with in recent years. Until not very long ago film photographers could count on the stability and consistent quality of products from three of the West's most venerable names: Kodak, Ilford, and Agfa.

As of this writing, all three of these companies have undergone major reorganizations and have either discontinued or modified many of the products that were once the foundations of traditional photographic processes. The most important of these changes will be summarized in the technical information offered in this chapter. For example, Kodak has changed the way they manufacture their films so we have retested and have new development times for all of their most popular films.

Note: There has been a lot of confusion about the extent to which Kodak's films are different from their predecessors. They of course have new names but Kodak's official word is that all they have done is relocate their manufacturing facilities and changed the way their emulsions are applied to the film bases. Also, there are web sites that claim to demonstrate that the classic standards of quality for films like Tri-X and Plus-X have not changed in meaningful ways. On th other hand, many photographers have reported that Kodak's films are simply not the way they used to be. My film-testing collaborator Iris Davis (owner of Davis Black and White, a high-quality custom photo lab in Oakland) and I have conducted extremely careful empirical tests of Kodak's new films and our results have shown that the grain structures and tonal gradations of Kodak's films are noticeably different from what they were before. The new development data are included below and, unfortunately, we no longer recommend 400TX (Tri-X) or 125PX (Plus-X) as we once did. Kodak's 100Tmax (T-Max 100) and 400Tmax (T-Max 400) films, on the other hand, still give excellent results. See Appendix F for a description of our testing method and Appendix G for Iris' comments on the new films and developers based upon her professional experiences.

Another major change is that Agfa-Gevaert no longer produces Rodinal that was once the developer of choice for photographers looking for the sharpest possible grain.

The good news is that, despite all of these changes, there are still excellent choices available to photographers devoted to film. The problem is that, in order to get the most from what you have learned about the Zone System, you have to understand in detail how it's concepts and principles apply to the range of films and developers that are still available.

One approach would be to work through the Zone System testing Method 1, described in the previous chapter. The experience and information that you can gain from completing such a test

like can be extremely useful. On the other hand, there are many good reasons why you may decide not to begin such a long procedure. You may, for example, already be confident that you know how the Zone System works or you simply may not have the time required to run a complete test. The problem is that you will still need a reliable ASA and Normal Development Time to effectively apply the Zone System to your photography.

Testing Method 2, described here, is very simple. The first step is to choose your film and to begin photographing using the ASAs and Normal Development Times that I suggest in the charts on pages 102–106. A wide variety of films and developers are listed there. If your favorites aren't listed, you will have to extrapolate from my times to suit your needs.

Below is a section titled Film and Developer Questions and Answers that offers detailed recommendations for which film/developer combinations offer the best results under specific criteria. Also see Iris Davis' real-world film and developer commentary in Appendix G. Together with the other information provided, this should help you decide on a film and developer to use to begin your work.

Note: **Neopan and Acros aren't included, but you can use the development times for films with similar speeds that are listed as starting points for working with these films.**

Normal Plus and Normal Minus Development times are also provided to give you all the information you will need to get started.

The second step is to keep a careful "diary" of your results and use this to modify and perfect your standards. A typical notation in your darkroom diary might look like this:

DATE	FILM	ASA	DEVELOPER	CONTRAST	TIME	RESULT
11/22	400TX	250	HC-110 (B)	N − 1	4 min.	N − 1 1/2

Assuming that your metering and placement were correct, this entry would mean that this negative needed a one-zone reduction in contrast (Contrast = N − 1). Developing it in HC-1 10 dilution B for four minutes reduced the contrast by 1 1/2 zones.

In other words, when you printed this negative on a normal grade of paper, the highlights were generally grayer than you wanted them to be. The result indicates that four minutes is too short a time for an N − 1 development in HC-1 10. The next time you encounter a subject that requires N − 1 development, you could refer to your record and try developing the negative for 4 1/2 minutes instead. This should be closer to the correct time for your work. Eventually you will arrive at personal times that you can count on for good results.

If your shadow values are consistently too dark, and you're sure that your placements are correct, try using a slightly lower ASA the next time you photograph with that film. An empirical testing method like this one will make you very sensitive to any changes in your image quality. Many experienced photographers find that keeping a running record of their darkroom results is a very useful habit. This approach essentially amounts to doing a Zone System test every time you photograph. If done properly it is no less rigorous, and the results will be adapted to your personal working methods.

This method has two potential hazards that should be mentioned.

1. Any errors in your technique or problems with your equipment automatically become a part of the process. The specific nature of any mistakes or technical flaws will inevitably surface because your results will be inconsistent or illogical in particular ways. You will then have to carefully review your thinking and procedures and tune up your equipment until the problem is resolved. This is a healthy part of any learning process.
2. The visual evaluations you will be making as you go along will necessarily be very subjective. This process is very different from comparing your Zone III, for example, to a printed standard. If, on the other hand, you are consistently happy with the results you get, you will have accomplished a great deal.

Development time recommendations for a variety of films are available from a number of sources. The Digital Truth web site contains a comprehensive listing of development times that are extremely useful as references for this process. Ilford publishes a list of development times for a long list of developers and films that is available on the Web and in many good camera stores. Kodak's data guide for black-and-white films also lists recommended Normal Development Times for Kodak products. Most film manufacturers also have toll-free numbers or web sites that offer free technical advice (see Appendix T). Any good camera store can provide you with these numbers.

Ansel Adam's classic book The Negative is another invaluable resource for information about developers and developing times. Charts of this kind provide useful starting points for determining your own specifications. You will most likely have to adjust your times as you go along.

About the Development Time Charts

The development times provided below are the result of extensive tests done under carefully controlled conditions designed for accuracy and consistency and to avoid technical flaws such as reciprocity failure, lens flare, and so on. See Appendix F for a description of the process used to define these data and Appendix G for commentary by Iris Davis.

Note: For the technically minded, my test negatives were consistently printed at the minimum time that it took to render the film base plus fog density as maximum black on grade 2 paper. The negatives were hand-processed and printed with a diffusion enlarger and machine-print processed.

We began this process by asking a number of basic questions.

Q: Which are the most popular and widely used products?

A: As I mentioned above, if your favorite film or developer isn't listed here, there should be something comparable that you can use to extrapolate your own time. Film speed is usually a reliable benchmark to use for comparison. If the film you want to try has an ASA close to one we recommend, use our times for that film as your starting point. Developers can generally be categorized by characteristics such as fine grain, high energy, and so on. See Appendix E.

Q: What is the highest film speed that renders a fully detailed Zone III and a Zone II that is black with texture?

A: Film manufacturers must necessarily use consistent and scientifically objective criteria for determining the ratings of their films. Photographers, on the other hand, need

ASA ratings that they can count on to give them the amount of shadow detail they visualize when considering a given subject. This is a very subjective evaluation and will vary somewhat depending on the kind of work you do and other variables such as the paper grades you like, and so on.

The standard we have used for these tests is conservative and intended to give you as much exposure latitude as possible, the highest ASA, and good shadow detail in Zone III.

Our goals were to produce negatives that would generally be easy to print on a normal grade of paper (grade 2). From this starting point you can begin developing your own personal standards.

A fundamental principle that all photographers should understand is that the effective speed of a given film varies depending on the developer used. Notice for example that 400TMax is rated as ASA 200 when developed in Ilford Perceptol, and ASA 400 when processed in Edwal FG-7 with a 9 percent solution of sodium sulfite.

What this demonstrates is that it's important to know as much as possible about how the characteristics of different developers and films interact before deciding on a combination to use as your standard. See Appendices E and G for more information on this subject.

Q: What is the minimum development time that renders a fully textured Zone VII, and a Zone VIII that is white with some texture?

A: The Normal Development Times recommended by film and developer manufacturers are based on scientific standards such as "developed to a contrast index of 0.56." Anyone so inclined will discover that there are very rational reasons for doing it this way, but all that most photographers need to know is that a given development time will give them negatives with printable highlights.

It is always best to work with minimum times to avoid highlights that are blocked up. Higher than normal grades of papers can be used if more print contrast is needed. See Appendix H.

Standard developer temperatures and dilutions were used in the tests charted below unless the tests indicated that an alternative gave better results.

Agitation rate is another important variable that effects development time and film speed. My agitation procedure is outlined in Appendix E under Processing Notes and on pages 262 of A Primer on Basic Photography.

The following development times are suggested for diffusion-type enlargers. Reduce these times by approximately 15% if you print with a condenser enlarger or if you are processing your film in a Jobo processor. See Appendix M.

> **Note: Development times that are shorter than 3 minutes in certain developers are listed as N.R. (Not Recommended) because it's very difficult to avoid uneven development. Also, the times are listed in minutes or fractions of minutes.**

Practical experience (and Kodak data sheets, if you look closely) indicates that T-Max developer isn't recommended for use with any sheet film. See the section on T-Max developer under Developer Notes in Appendix E.

Note: These development time charts are listed in the order of my preferences for quality.

Development Time Charts

EDWAL FG7 WITH 9% SODIUM SULFITE DILUTED 1:15 AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
400TX	320	6.5	9	12.5	5	4
400TMax	400	6.5	7.25	8	6	5
HP-5+	400	8	11	15.5	5.5	4.5
Delta 400	400	9	10	11	8	7
125PX	125	7	9.5	14	6	5
FP-4+	80	8	11	15.5	5.5	4.5
100Tmax	80	7.5	8.5	9.5	6.75	6
Delta 100	100	6.5	7.5	8.5	6	5.5
Pan F	50	6.5	9	13	5	4

KODAK XTOL DILUTED 1:1 AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
T-Max P3200	2400	15	16.5	18	13.5	12
Delta 3200	1600	15	16	17.5	13.5	12
400TX	200	7.5	10.5	15	5.5	4.5
400TMax	400	9.5	10.5	11.5	8.5	7.5
HP-5+	400	9	12.5	17	6.5	5.5
Delta 400	400	10	11	12	9	8
125PX	64	7	10	14	5	4
FP-4+	64	9.5	13	18	6.5	5.5
100TMax	100	9.5	10.5	11.5	8.7	7.5
Delta 100	80	10	11	12	9	8
Pan F*	50	8	11	15.5	5.5	4.5

*For this film we used XTOL as a stock solution.

KODAK D76 DILUTED 1:1 AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
Delta 3200	N.R.					
Tmax P3200	2400*	18	20	22	16	15
400TX	320	8.5	12	16.5	6	
400TMAX	400	12	17	N.R.	10	9
HP-5+	400	8	11	15.5	5.5	4.5
Delta 400	320	11	12	13	10	9
125PX	80	11	15.5	21	7.5	6.5
FP-4+	80	8	11	15.5	5.5	4.5
100Tmax	80	10.5	11.5	13	9.5	8.5
Delta 100	100	11	12	13	10	9.5
Pan F	50	13	18	N.R.	5	4

*For this film we used D76 as a stock solution.

KODAK HC110 DILUTION B (1:7 FROM STOCK or 1:31 FROM CONCENTRATE) AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
Tmax P3200	2400	9.5	10	11	9	8
Delta 3200	1600	15	16.5	18	13.5	12
400TX	320	5.5	7.5	10.5	4	N.R.
400TMax	400	6.5	7.25	8	6	5.25
HP5+	200	5.5	7.5	10.5	4	N.R.
Delta 400	320	5	5.5	6	4.5	N.R.
125PX	125	6.5	9	12.5	4.5	N.R.
FP-4+	64	7	10	14	5	4
100Tmax	100	6	6.5	7.5	5.5	4.5
Delta 100	80	5.5	6.25	7	5	4.5
Pan F	50	6.5	9	13	4.5	N.R.

ILFORD ILFOTEC HC 1:31 (FROM CONCENTRATE) AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
TMax P3200	3200	10	11	12	9	8
Delta 3200	1600	15	16.5	18	13.5	12
400TX	320	5.5	7.5	10.5	4	N.R.
400TMax	400	7.5	8.25	9	6.75	6
HP5+	400	7	9.75	13.5	5	4
Delta 400	320	7	8	9	6.5	5.5
125PX	64	7.5	10.5	15	5.5	4.5
FP4+	80	8	11	16	6	5
100TMax	50	9	10	11	8	7
Delta 100	80	6.5	7.25	8	6	5.5
Pan F	50	7	10	14	5	4.5

KODAK TMAX DEVELOPER DILUTED 1:4 AT 68 DEGREES (TANK DEVELOPMENT FOR ROLL FILM ONLY*)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
400TX	320	5.5	7.5	10.5	4	N.R.
HP-5+	320	7	9.75	14	5	4
Delta 400	400	7	8	9	6.5	5.5
125PX	80	7	10	14	6	5
FP-4+	64	7	10	14	6	5
Delta 100	100	7	7.75	8.5	6.5	5.5
Pan F	32	8	11	16	6	5

*T-Max developer isn't recommended for use with sheet film.
See the Kodak T-Max section in Developer Notes in Appendix E.

KODAK TMAX DEVELOPER DILUTED 1:4 AT 75 DEGREES (TANK DEVELOPMENT FOR ROLL FILM ONLY*)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
TMax P3200	1600	11	12	13	10	9
Delta 3200	1600	9	10	11	8	7
400TMax	400	6	6.5	7.25	5.5	4.75
100TMax	80	6	6.5	7.5	5.5	4.5

*T-Max developer isn't recommended for use with sheet film.
See the Kodak T-Max section in Developer Notes in Appendix E.

KODAK TMAX RS DEVELOPER (STOCK) AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
TMax P3200	2400	10	11	12	9	8
400TX	320	5	7	10	4	N.R.
400TMax	400	8.5	9.25	10	7.75	7
HP-5+	400	5.5	7.5	10.5	4	N.R.
Delta 400	400	8	8.75	10	7	6.5
125PX	80	7	10	13.5	5	4
FP-4+	64	7	10	13.5	5	4
100Tmax	100	9	9.5	10	8	7
Delta 100	100	5.5	6	7	5	4.5
Pan F	50	7	10	14	5	4.5

ILFORD ID-11 DILUTED (STOCK) AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
400TX	320	8	11	15.5	5.5	4.5
400TMax	320	8	9	10	7	6
HP-5+	320	8.5	12	16.5	6	5
Delta 400	400	10	11	12	9	8
125PX	80	8.5	12	16.5	6	5
FP-4+	80	9.5	13	18	9	7.75
100TMax	80	8.5	9.5	10.25	7.5	6.5
Delta 100	80	8.5	9	9.75	7	6
Pan F	50	8.5	12	16.5	6	5

ILFORD PERCEPTOL DILUTED (STOCK) AT 68 DEGREES (TANK DEVELOPMENT FOR SHEET OR ROLL FILM)

FILM	ASA	NORMAL	N + 1	N + 2	N − 1	N − 2
400TX	200	12	17	N.R.	10.9	
400TMax	200	12	17	N.R.	10	9
HP-5+	320	13	18	N.R.	9	8
Delta 400	320	10	11	12	9	8
125PX	64	12	17	N.R.	10	9
FP-4+	64	12	17	N.R.	10	9
100Tmax	50	12	13	14	11	10
Delta 100	50	13	14	15	12	11
Pan F	32	12	17	N.R.	8.5	7

Remember that the development times listed above are only starting points for determining your own standards.

Film and Developer: Questions and Answers

Students and friends inevitably ask a number of general questions regarding film and developer combinations. The following are my answers to these questions. Keep in mind that these are very subjective responses based upon years of testing and working with these products. Other photographers may have different preferences that are appropriate for their work.

> **Note:** The detailed explanations for these results can be found in Appendix E in the sections Developer Notes and Film Notes. Also see Appendix G for some personal commentary on films and developers offered by Iris Davis.

Q: What film/developer combination gives the finest grain with good shadow detail and the best overall contrast?

A: Kodak T-Max 100 in HC-110 (B).

Q: What film/developer combination gives the fastest speed with the least grain?

A: Ilford Delta 400 in XTOL.

Q: Which developers give the finest grain with good shadow detail and the best overall contrast with the films you have tested?

A: See chart below.

FILM	RECOMMENDED DEVELOPER
Kodak P3200	Ilfotech 1:31 from concentrate @ 68 degrees
Delta 3200	HC-110 (B)
Kodak 400TX	Ilfotech 1:31 from concentrate @ 68 degrees
Kodak 400Tmax	Edwal FG-7 with sodium sulfite
Ilford Delta 400	XTOL 1:1
Ilford HP-5+	Edwal FG-7 with sodium sulfite
Kodak 125PX	XTOL 1:1
Kodak T-Max 100	HC-110 (B)
Ilford FP-4+	Edwal FG-7 with sodium sulfite
Ilford Delta 100	Edwal FG-7 with sodium sulfite
Ilford Pan-F+	XTOL stock

Q: Which film/developer combination gives the finest grain, the fastest film speed, and the best contrast when a very high-speed film is called for?

A: Kodak Tmax P3200 in Ilfotech HC dilution 1:31.

Chapter 10

The Zone System and Digital Photography

Introduction

Almost 15 years ago I walked into a fine art photography gallery in San Francisco and, with a wry smile, the owner told me that he had some prints by Graham Nash that he thought I should see. To be honest I wasn't expecting them to be more than interesting backstage portraits of rock stars, but what happened next completely changed my sense of what a photographic print could be.

He took me to the print viewing room in the back of the gallery and pulled a large print from a drawer that at first didn't seem unusual; until I noticed that it had a deep and rich but somehow soft quality of blacks that I had never seen before. When I realized that it was printed on what looked to be fine art drawing paper and he told me it had been made with what he called an "Iris printer" attached to a computer, I was at first stunned, and then amazed and delighted! I was having a completely photographic experience through a process I had never even heard of before.

In those days Iris printers cost more than $100,000 so I knew that my photographic life wouldn't change overnight, but suddenly there was a new horizon that seemed extremely interesting.

Now of course, for a number of very good reasons, digital photography has quickly become the dominant working method for all types of photographers. It is now possible to produce prints that are extraordinarily beautiful without exposing yourself to photochemistry; and the process is both incredibly flexible and fun, that is if you enjoy working on images in front of a monitor.

The debate between "purists" and digital converts is the inevitable expression of personal aesthetic preferences more than a fundamental schism in photography itself. Ansel Adams was one of the first to recognize and adopt Polaroid materials and I'm certain he would be using digital processes if they met his extremely high standards for print quality. If for some those standards aren't being met today, they will be very soon.

But there are many, often contradictory, misconceptions about digital photography. Some people think that it's a hopelessly complex process that only photo-geeks can master.

On the other hand, some of the obvious differences between the two processes give some photographers the impression that learning new exposure and contrast control techniques aren't really necessary; as if digital processes could magically provide solutions to some of

photography's technical mysteries. Let's take a look at some of these differences and see what they can teach us:

- First of all, digital cameras give you a small, instant preview of your image, along with warnings about excessive contrast that may be beyond the range of the process to render. This is like having a tiny, electronic form of Polaroid photography, which would seem to eliminate the need to precisely calculate your exposure in advance because you can always make adjustments as needed.
- Also, with digital processes there is no film to develop, and we learned in Chapter 6 how important it is to be able to use film development times to control the contrast of your negatives to facilitate fine printing.
- Finally, digital processes move your image into the vast realm of Adobe Photoshop and the almost infinite number of ways it allows you to manipulate and enhance your prints.

But, as you will learn, each of these factors contains insights into how important it is to better understand and apply some of the basic principles of the Zone System; although using methods that are unique to digital photography.

For example, the thumbnail previews that digital cameras provide are often useful but of course they only appear *after* you've already taken a given photograph. If that particular image was the one you wanted and it's badly underexposed, you have a problem. Understanding the principles of exposure and contrast control allows you to know in advance how your image will turn out.

Also, digital camera previews can be deceptive because those little images are actually altered by the camera's internal software based upon generalized assumptions about the way you will want the image to look. This is often helpful, but sometimes it exaggerates problems that are actually easily correctable if you understand how to manipulate the contrast of digital image files.

Finally, although Photoshop is by far the most powerful and complex image-editing tool ever created, there are practical limits to what you can do to correct digital images that are badly underexposed or have too much contrast. Understanding these limits is essential for getting the most out of your digital work. In this sense, film and digital photography have more in common than it may seem at first.

A Word about Structure and Understanding

This chapter has two related objectives. The first is to provide readers with a clear and simple method for obtaining the best possible quality in their photographs.

The second goal is to provide a broad understanding of the basic technical concepts that underlie digital image processing.

These two goals might seem to be the same but they really aren't.

If what you are looking for is a general understanding of digital exposure and contrast control so you can get better results, this text is structured so you can read straight through without

getting bogged down in the mathematical details of things like bit depth and the digital linear effect. (The truth is, unless you're Thomas Knoll, the primary architect of Adobe Photoshop, most of us only have a relative understanding of these things anyway.)

When you get to those sections you can simply accept my assumptions about what these concepts mean for your work and read on.

If, on the other hand, you're like me and find that developing some understanding of concepts like these is fascinating and important, the text will direct you to appendices that more fully explain these subjects. In addition, Appendix S lists technical source books that will take you as deep into the numbers as you would like to go.

The Automatic Alternative

Many people new to digital photography quickly discover that they can obtain perfectly adequate results using the automatic metering systems provided by camera manufacturers to simplify the shooting process.

Automatic metering modes work well but there are two consequences from overly relying on them. First, they necessarily compromise the quality of your work in situations where a better understanding of photo-technique would allow for more innovative results. If you look closely at the most creative work, you will see that artists understand how to depart from normal ways of working in ways that are beautiful and meaningful. Automatic metering systems aren't designed to do this.

The second consequence of relying on automatic systems is that they prevent you from engaging with and really understanding the details of important photographic techniques. This is especially true with digital photography where there are layers of technical concepts that will be new to most photographers. Most serious photographers will find that the time spent learning more about their systems is worth the effort.

Color Management

Unless you're a very experienced digital image editor and printer, it's probably a good idea for you to read Appendix A on the subject of Color Management before you attempt to apply what you will learn in this chapter. Color Management is the term used to describe the process of calibrating and setting up your system so that your printer produces images that match what you see on your monitor. Many photographers new to digital processes take this step for granted and end up frustrated and waste lots of ink and paper attempting to produce predictable results.

My hope is that the information in Appendix A will resolve all of this and make the process of printing your work as efficient and straightforward as is possible.

Scanning

As one of the two ways that photographic images enter the digital world, scanning is an important topic of this book, especially as it relates to the issues of image resolution, bit depth, and image quality.

On the other hand, this chapter will not discuss the problems that result from scanning negatives or prints that are badly underexposed or overdeveloped. Reading the preceding chapters

of this book will teach you how to avoid producing unworkable negatives and prints in the first place.

Teaching Approach

As I mentioned in the introduction to this edition, this chapter will not attempt to describe all of the many ways that these techniques apply to all of the many brands of cameras and applications that are available. No book could do that, if only because things change so quickly and dramatically in this field.

Instead, what I'll do is stick to fundamental principles that apply to all digital processes and describe how these work with one typical system that I know very well. (See Basic Assumptions below.) I call this the "straight and narrow path" to technical education. My experience has been that once you clearly understand how to solve these problems with one camera and operating system, learning how to apply them to your own equipment isn't so difficult.

Basic Assumptions

Let's begin by defining some of the tools, systems, platforms, and preferences upon which this chapter is based:

Platform and Operating System

It was once fair to say, in the field of computer graphics, that Apple Macintosh computers were far superior to PC-based systems. This is no longer true. These days, although artists, graphic designers, and educational institutions still favor Macs, PCs are fully capable of producing results that are just as good as anything done with the Macintosh. And in fact, because of the dominant position of PCs in the market, certain tools and software applications often appear in PC-based versions before they are available for Macs. It's purely a matter of your preferences which system you choose at this point.

But, for the purposes of this chapter I should make clear that my preference is for the Mac and all of the instructions I cite will be based on the Apple Macintosh OS 10.4.7 system, which is the most current as of this writing. The PC-based commands are very similar so readers using that system should have little trouble finding the equivalents.

Applications

As I write this, the most current version of Adobe Photoshop is 9.0.1 otherwise known as CS2. I'm also using version 3.4 of the Camera Raw plug-in. Some of the techniques I describe are only available on these versions. I'm also assuming that anyone reading a chapter on digital photography is somewhat familiar with Photoshop's basic functions and tools. Consult Appendix S for references to a number of excellent books on Photoshop if necessary.

Digital Camera Choices

The digital camera I used for the examples in this chapter is the Nikon D70, one of the first DSLRs to provide both professional-level features and quality at a consumer-oriented price. There are many other digital cameras that fall into this category, most notably the Canon EOS 20D but, once again, all of the principles I cite apply in very similar ways to cameras in this price and feature range. In general, point-and-shoot type cameras aren't capable of producing images that will work with these techniques.

Digital and Film Photography

Similarities and Differences

The basic photographic principles relating to apertures, depth of field, shutter speeds, and metering, etc., are essentially the same as film-based photography when you're working with professional digital SLR cameras.

This means that photographers beginning to make the transition to digital imaging don't have to relearn what they already know about basic photography and that's reassuring. But, as we will see, the fact that these basic photographic principles are being applied to digital media has real consequences when it comes to effective exposure and contrast control techniques.

To better understand how the two approaches compare, let's begin with an overview of the digital and film-based photographic processes.

The Digital Photographic Process

There are four basic steps that every photographic frame goes through that each has a dramatic effect on the quality of the final print:

1. ISO Selection
2. Exposure
3. Processing
4. Printing

Both film and digital photography share these steps and it's important to understand them. Experienced photographers take each of these steps very seriously and therefore get generally better results.

Beginning or casual photographers don't understand the implications of these steps and either neglect or try to automate them, which is why they generally get inconsistent or mediocre images in the end.

Using the familiar film-based process as a model, I would like to explain each step's digital equivalent so you can understand why I'm recommending that you make certain decisions about how to expose and process your digital images. As I move through these explanations I'll highlight a number of cardinal rules that will give you better results.

Step 1 – ISO Selection

Before you do anything else when taking a picture it's important to know the sensitivity rating of the media you plan to use. With film photography we've learned that we have to choose a faster film if we're planning to shoot under low light conditions. The trade-off is that faster films produce grainier prints.

Digital processes work in a similar way with two important differences:

1. Digital cameras allow you to change the ISO for each frame that you shoot, which gives you greater flexibility and this is an enormous advantage.

2. Instead of film grain, using higher ISO speeds with digital cameras adds what's called "noise" or random pixels of either brightness and/or color in the shadow areas of your image.

FIGURE 69 Digital noise.

This means that digital underexposure has two consequences that you have to cope with instead of one: As with film, the underexposed shadow areas are too dark and lack detail, but with digital images you also have to deal with noise in your shadows, which can be unsightly and distracting.

For these reasons, the first cardinal rule for digital photography is:

Unless you want dark and noisy shadow areas for aesthetic reasons, **always use the lowest ISO possible with digital cameras.**

There are effective software tools you can use to minimize or totally eliminate noise from digital images, but using these can also degrade your image by obscuring fine detail if you don't use them properly. See Appendix T for a list of helper applications that I recommend.

Step 2 – Exposure

Digital camera light meters behave in essentially the same way as those in film cameras. They both average the brightness of the reflected light they see to an exposure that prints as middle 18% gray or Zone V. *

*To be more precise, all light meters are actually calibrated using ANSI standards to produce images that are 12% gray or 1/2 stop less that the 18% gray you see in Kodak Gray Cards, see http://www.bythom.com/graycards.htm.

This is something you can test very easily with a digital camera by shooting three frames one after the other in the following way:

- Set your camera to one of its automatic metering modes, entirely fill the viewfinder with an evenly lit very dark surface, and shoot first frame.
- Using the same automatic metering mode, completely fill the second frame with a middle gray surface and shoot it.
- Automatically meter and shoot the whole third frame with a very light surface.

When you look at the previews of these three frames you will see that they're very close in value and only the second frame actually looks like what you shot.

Note: The broader implications of this effect are spelled out in Chapter 5.

Although digital and film camera meters behave in the same way, because of fundamental differences in the way that digital chips measure light, the basic rules for applying the Zone System to digital photography are the opposite of those for film.

The second cardinal rule for digital photography is: **expose for the highlights and process for the shadows.**

I fully explain why this is true in the later section The Zone System of Digital Exposure.

Step 3 – Processing: Camera Raw

After you expose a frame of normal photographic film the image first exists in what's called an invisible "latent" state. All of the subject's brightness values have been captured and are encoded in the emulsion, but they aren't visible until after the film has been "developed" in the three baths called Developer, Stop, and Fixer. After development the visible image has been fixed in the negative and there isn't much you can do to change it.

I know that all of this is perfectly obvious to readers of this book but I'm overstating it to make the point that conceptually, a very similar process applies to digital photography and this has profound implications for how you should work with digital images.

After you expose the digital camera sensor to light from the subject, the image first exists in a latent state known as "Digital Raw," which contains visual information that can't be seen until the image has been processed or "Converted" into a form that can be viewed on a digital monitor, either as the small preview on your camera, or as the image you see on your computer screen.

The development or conversion process is done electronically and if you don't preserve this raw image, all of the information it contains is lost forever. This would be like throwing away your negative after making your first print.

So, another fundamental difference between digital processes and film is that the unprocessed, digital latent or raw state of the image can be preserved even after the image has been processed (converted). Latent film images are always lost when the film is developed.

Just as with film photography, it's very easy to tell the difference between unconverted and converted digital images: On your computer screen you see raw images as generic icons with extensions like .nef, .crw, or .dng, which stand for the universal standard "Digital Negative." The reason the raw image icon is generic is because your computer has no idea of what the unconverted image looks like; just as with film if it were possible to see an undeveloped frame with visible light.

The developed or converted form of the image has a thumbnail icon and an extension like the familiar: .jpg, .tiff, or .psd for images that have been converted into Photoshop files.

Photographers new to the digital world are often confused about this step because the conversion actually happens twice and in different ways in the digital process. The first time the image is converted is instantly in a generalized way into the thumbnail you see on the camera's small screen. This preview is based on default settings built into the camera and are only a rough approximation of the second, more refined conversion you can do once the image has been downloaded to your computer.

But the point remains, digital images can exist in two distinct states — Raw and Converted — just like undeveloped and processed film.

The differences between these two states is extremely important to understand because raw digital image files contain vastly more visual information than the converted state, especially when the conversion is into the popular JPEG format used by many photographers and applications.

JPEG formatted images are compressed and processed into a form that is typically two to four times smaller than the raw file of the same image, so it can never make a print that is as large with the same quality.

The raw digital image not only has much more visual information, it also has information called "metadata" that records things like the exposure you used, the focal length of the lens, and the ISO used. Some cameras are even equipped with GPS software that allows you to know precisely where and when the image was taken!

Many new digital photographers either inadvertently buy cameras that don't offer the raw format as an option or they convert their images to JPEGs and throw this information away without realizing what they are doing. If nothing else you should make a practice of archiving the raw version of our best work, just as you would your negatives.

The vital thing to know is that, if you choose to shoot your digital images in JPEG format, the conversion happens immediately and this information-rich raw latent image is never even created!

This gives us our third cardinal rule for digital photography:

Always shoot in Raw format unless you are certain that you will never need the visual information and metadata stored in the raw digital file.

It's true that shooting in the raw format gives you fewer images per storage card or disk, but since you will never have to buy film for your camera, it's economical to buy a larger storage media and convert your images to JPEGformat if you need to later.

Step 4 – Printing

Needless to say, there are profound differences between the digital and film-based photographic printing methods. Digital printer manufactures strive to make the prints from their products match the quality of fine silver prints and there will always be differences that are obvious to experts. Whether one is qualitatively better or more beautiful than the other is something that will always be debated, but this clearly has more to do with the aesthetic skills and vision of the maker than anything else.

While it's true that in purely formal terms you can produce effects with digital printing processes that would be difficult or impossible to reproduce in a darkroom, I firmly believe that it's important for photographers to internalize the skills that come from using your hands and body in a traditional darkroom before devoting your time to digital printing. But then again, I know that this is a bias that's tinged with nostalgia. It will be interesting to see how photographers who are just beginning respond to developing their aesthetics in a purely digital environment. My guess is that digital photography will simply be another tool that expands rather than radically reforms the way artists use it to express themselves.

Pixels: Size, Quality, Resolution and Bit Depth

The representational power of digital photography begins with individual picture elements called "pixels." If you enlarge any digital image enough you will see that the apparently continuous tonalities of the image are actually created from these tiny individual image tiles.

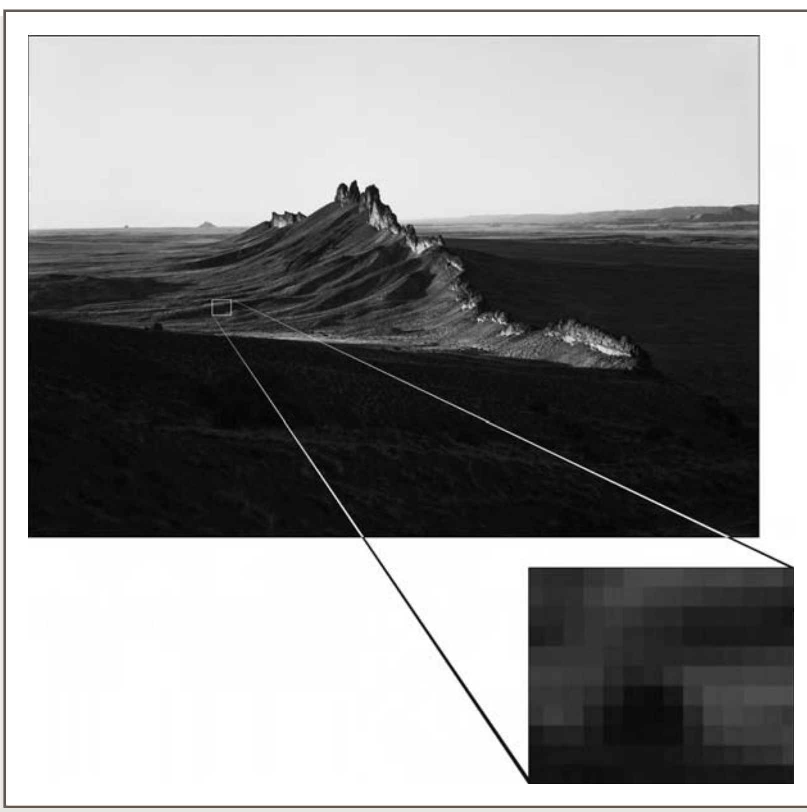


FIGURE 70 Digital image pixels.

And yet, despite how familiar we are with the general idea of pixels, there is still a lot of confusion about what they actually are.

There are three essential things you need to understand about pixels and each of these has important implications for the quality of digital photographs:

1. There are two general types of pixels: fixed-sized Hardware Pixels and variable-sized Image Pixels.

2. Although image pixels can be almost any size, in black-and-white digital images each pixel can only be **one individual tone of black, gray or white. In color digital images each pixel can only be one single color**.
3. Although each individual pixel in an image can only be one tone or color, the number of different tones or colors a pixel is allowed to be by current computers can be vast!

Hardware pixels are physical things built into digital sensor chips, computer monitors, scanners, and ink jet printers.

The function of hardware pixels is to gather, display, and reproduce the visual information that we see as **Image Pixels**.

For example, on the surface of a computer monitor, a "pixel" is a fixed and rigid physical entity that can never change size. The resolution of monitors is set to values like 72 or 96 pixels per inch and that always remains the same.

But keep in mind that these "monitor pixels" are only the tiny dots that actually create the "image pixels" you see on the screen.

When the screen is displaying a digital image, these "screen pixels" are used to create "image pixels" that can be almost any size depending on how many screen pixels are devoted to them. For example, when one screen pixel is used to reproduce one image pixel, the image display in Photoshop reads 100% or "Actual size." When two screen pixels are used to display one image pixel the image shrinks to 50%.

Another example of this relationship between fixed and variable image pixels would be the physical holes in the print heads of ink jet printers that spread minute clouds of pigment on paper to reproduce the image pixels we see in prints.

(See Appendix B for more details about pixel size relationships.)

When a digital photograph is either displayed or printed the number of pixels per inch that you see is defined as the image's "resolution." This is one key factor that determines a digital image's quality. For example, if there are 300 pixels in one inch of an image we would consider that to be a high quality image. If there are only 10 we would say the image quality was very poor. Much more on this shortly.

The number of different tones or colors that a pixel is allowed to be in a digital image is a measure of what's known as the pixel's "Bit Depth." This is another key determinant of a digital image's quality.

As you will see from the following examples, learning how to optimize both the resolution and the bit depth of an image's pixels are important skills for digital photographers who want the most from their work.

The Quality of Digital Images

It's always a little ironic when someone looks at a fine digital print and says that it looks just like a "real" photograph. But of course what this really means is that the technology is doing exactly what it hopes to do; that is, translate a purely electronic digital file into what appears to be a full-fledged, continuous tone photographic image.

In purely technical, and very general terms, most digital photographers would agree that Figure 71 is an example of a “high quality” image and Figure 72 is an exaggerated “low quality” version of the same photograph.

FIGURE 71 High quality digital image.

FIGURE 72 Low quality digital image.

To better understand the differences between these two images, let's translate them into aesthetically neutral gradations that represent the tonal values in each photograph.

FIGURE 73 High quality digital gradation.

FIGURE 74 Low quality digital gradation.

Using these two gradations as examples, we can now say that what digital photographers mean when they speak of "image quality" is the goal of reproducing smooth, gradually continuous gradations that are typical of analog imaging media like film.

For reasons you will soon understand, Figure 74 has noticeable steps in the transitions from one tone to the next.

The more smooth and seamless the transitions are from one tonal value to the next, the higher the image quality is said to be.

With these ideas in mind, the following example will illustrate how both resolution and bit depth determine the quality or smoothness of the above gradations.

Imagine that each pixel in the above gradations is a step in a flight of stairs. The "resolution" of the staircase would be a measure of the actual size of each individual step (pixel); the smaller the step the more smooth the gradation.

But keep in mind that although the size of each pixel (step) can change, it can still only be one tonal value. In this case, each pixel is limited to one of only ten different tonal values.

This can be illustrated like this:

a. Low Resolution/Low bit depth b. High Resolution/low bit depth

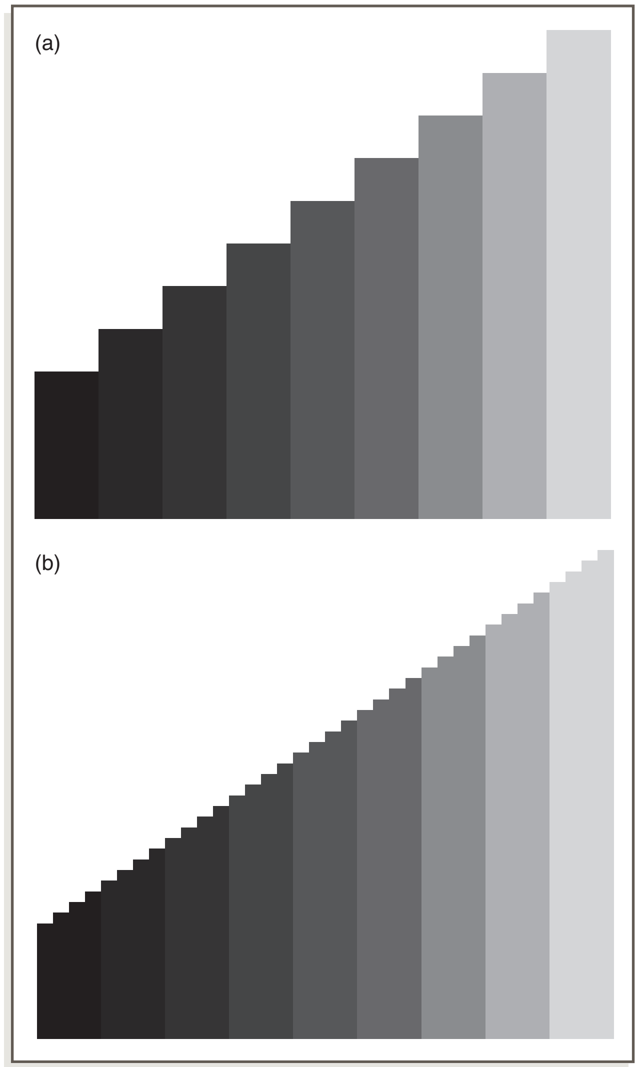


FIGURE 75 Low and High Resolution Illustration.

Notice that by greatly increasing the resolution of Figure 75(b) its slope is much smoother. It has much smaller pixels (steps) but the gradation itself is still not continuous, because the number of individual tonal values that each step is allowed to be in this illustration is still limited to 10.

Remember that we defined bit depth as the number of different tonal values (also known as "levels") that each pixel is allowed to be in a given image.

With this in mind we could say that Figure 75(b) would be an example of a high resolution, but low bit depth image.

Increasing an image's bit depth allows each pixel to be more levels of tonality.

If we were to optimize both the resolution and the bit depth of this illustration the result would look like this:

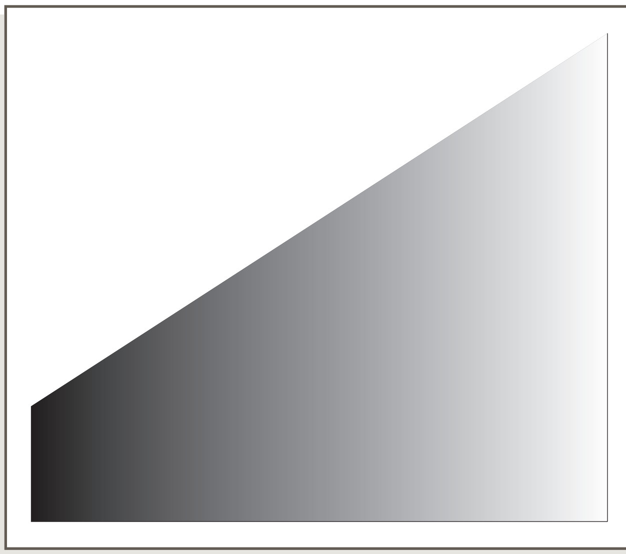


FIGURE 76 High resolution, high bit depth illustration.

What this illustration makes clear is that learning how to optimize both a digital image's resolution and its bit depth are important for achieving the best quality in your work.

Optimizing Digital Image Resolution

Pixel editing software makes it possible to radically alter many characteristics of digital images, which include the size and color of pixels and your image's contrast and sharpness along with many other qualities.

But in this sense, bit depth and resolution can be considered Core Digital Values because the only time it's possible to establish these qualities is when the image is captured, either by a digital camera or a scanner. This is because bit depth and resolution are functions of the amount of memory your scanner or digital camera commits to actually gathering visual information from your subject, and once the subject is out of sight this is no longer possible.

Digital editing software provides you with very tempting options for increasing the resolution of digital images if you discover that the resolution is too low after your image has already been scanned or captured. This is called "interpolation."

The problem is that when you interpolate you are asking the computer to mathematically simulate visual information that it can't actually see. This always results in a noticeable loss of image quality.*

Understanding how to optimize a digital image's resolution begins with having a very clear idea of how you ultimately intend to display your photograph. The optimal resolution for an

*This principle only applies to bitmapped or rasterized images that are made from image pixels. Vector-based images can be scaled to larger sizes without a loss of quality. See the Glossary for definitions of these terms.

image that will be displayed on the Web is very different from one that you intend to print with an ink jet printer.

The more thought you give to this decision at the beginning of the process, the more you are likely to avoid painful choices in the end.

For this reason our next cardinal rule is: **Capture or scan at resolutions and bit depths based upon the type and ultimate size of your final image and never interpolate unless it can't be avoided.**

The following steps will show you how to optimize your resolution for different digital outcomes.

Optimizing your Scan

Scanner types fall into categories defined by the material they are designed to digitize and the level of quality they can produce. It is also vital to understand the difference between the actual optical resolution capabilities of a scanner and the amount of information it can literally see, as opposed to the virtual or advertised resolution of the scanner, or the amount of information it can fake through interpolation. Once again, always use a scanner's optical resolution as your standard. Avoid interpolation unless you have no other choice.

> **Note: Adobe Photoshop's interpolation technology has improved to the point where minor upsampling can be done without noticeably degrading your image. On the other hand, if you decide that major increases of the file size of your image are necessary consider using special applications that are designed for this purpose. See Appendix T for Photoshop-related applications.**

Dedicated Film Scanners

These are ideal for producing high-quality scans of 35 mm film. You should always scan at no less than 4000 dpi and set the scale size to 100%. Anything more than these settings is interpolation. You can always redistribute the scanned pixels to end up with a larger image using the Photoshop Image Size command. The trick is to uncheck the Resample Image box as illustrated below.

There are two types of larger format scanners, **Flatbed** and **Professional Drum** or **Imacon** scanners. Professional scanners always produce higher quality scans but these aren't always essential for digital photographers working with current ink jet printers.

The Scanning Process

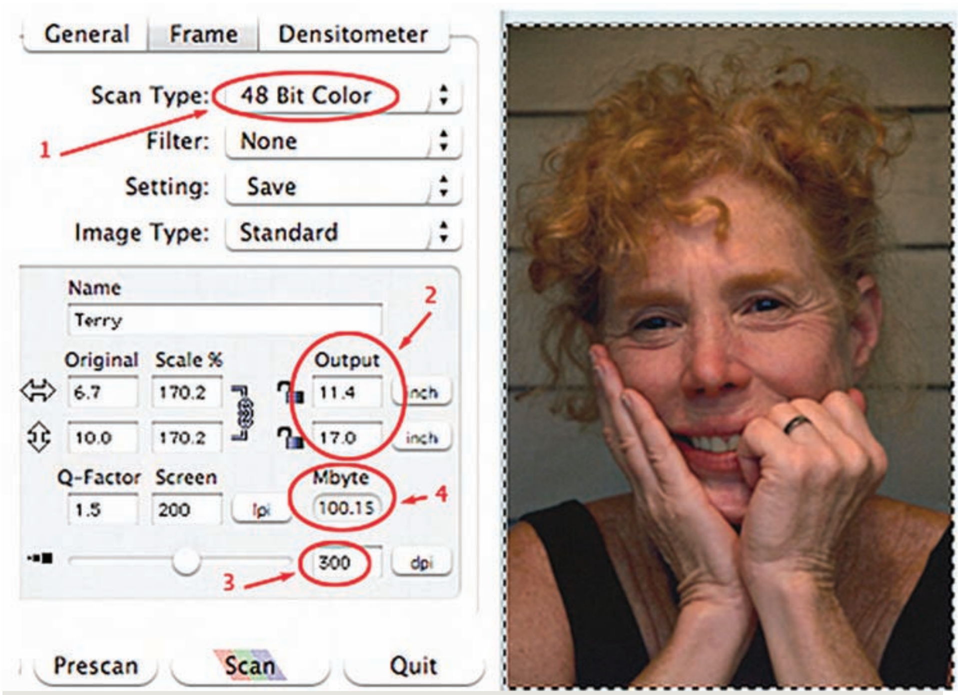


FIGURE 77 Optimal Flatbed Scanning.

In Figure 77 my intention is to make an 11.4 × 17 inch ink jet print of this image, but we will use this scanning illustration to learn what's involved with creating optimal scans for a variety of different uses.

1. **Bit Depth.** Notice that I have set the bit depth to "48 Bit Color."

> **Note: The number 48 means that each of the three color channels — Red, Green, and Blue — will contain 16 bits of visual information. 16 × 3 = 48. More on this later.**

   This setting will create a digital file with the highest bit depth possible with this scanner. As you will learn later in the section Bit Depth and Digital Exposure, having the maximum number of pixel levels will allow me to edit the contrast of this image without compromising the quality of the resulting print.

   When you shoot your work in the camera raw format you're also creating high bit depth images that maximize the number of pixel levels in our image.

2. **Output Size.** It is essential that you set the Output setting to the largest size print you ever intend to make. It's always possible to downsample your digital image file to a smaller size without losing quality but scaling it up through interpolation will degrade the image.
3. **Resolution.** Scanners often display their resolution settings in terms of dots per inch (dpi). This is in recognition of the fact that nothing is more important than sending an ideal digital file to your printer!

- **Optimal Resolution for Ink Jet Prints.** The minimum resolution you should consider for fine digital prints is 240 dpi. The standard scanner resolution setting for digital prints at 300 dpi, although some say that 360 dpi is ideal.
- **Optimal Resolution for the Web.** If the only place you plan to display your image is on a computer monitor, for example, if your image will only appear in a web browser, there is no reason to scan at a resolution higher than 72 dpi, the fixed pixel size of computer monitors.
- **Optimal Resolution for the Print World.** The major stock agencies are setting the standards for professional scans intended for A3 or double page spread printing. The scanning resolution they require for this is 600 dpi.

  Just as important, these companies are requiring incoming images that they represent to have a minimum file size, 30 megabytes for one example, and that these images only have 8 bits per channel and not be interpolated.

  The meaning of the words "8 bits per channel" will be discussed very shortly.

  To meet this requirement, digital stock photographers are using digital cameras with at least 11 megapixel sensors, shooting in raw format if they intend to edit the images, and then reducing the image's bit depth to the 8 bit per channel minimum standard.

  This is in recognition of the fact that although it's important to scan or capture your images at the highest resolution possible if you intend to edit them in Adobe Photoshop, there is no quality advantage to sending more than 8 bits per channel of information to ink jet or offset printers.

4. **File Size.** Notice that the settings I've chosen for this scan will result in a file that is just over 100 megabytes in size. Ultimately this is the most important number in the box!

Pioneering child psychologist, Jean Piaget, is famous for creating a test of cognitive development that uses two cubes of clay that are exactly the same size. Most children will readily say that they are the same. But, if you then flatten one cube until it covers a wide area, children below a certain level of development will claim that the cube contains less clay. A similar principle applies to the world of digital photography.

The quality of an image you create is always determined by the combination of the image's resolution, bit depth, and pixel dimensions; in other words, the total amount of visual information you have captured or scanned, not any one of these individually.

The following is an example of how this works. For the image in Figure 77, my goal was to create a fine ink jet print that was 11.4 $\times$ 17 inches high. Figure 78(a) is the Image Size box for this scan.

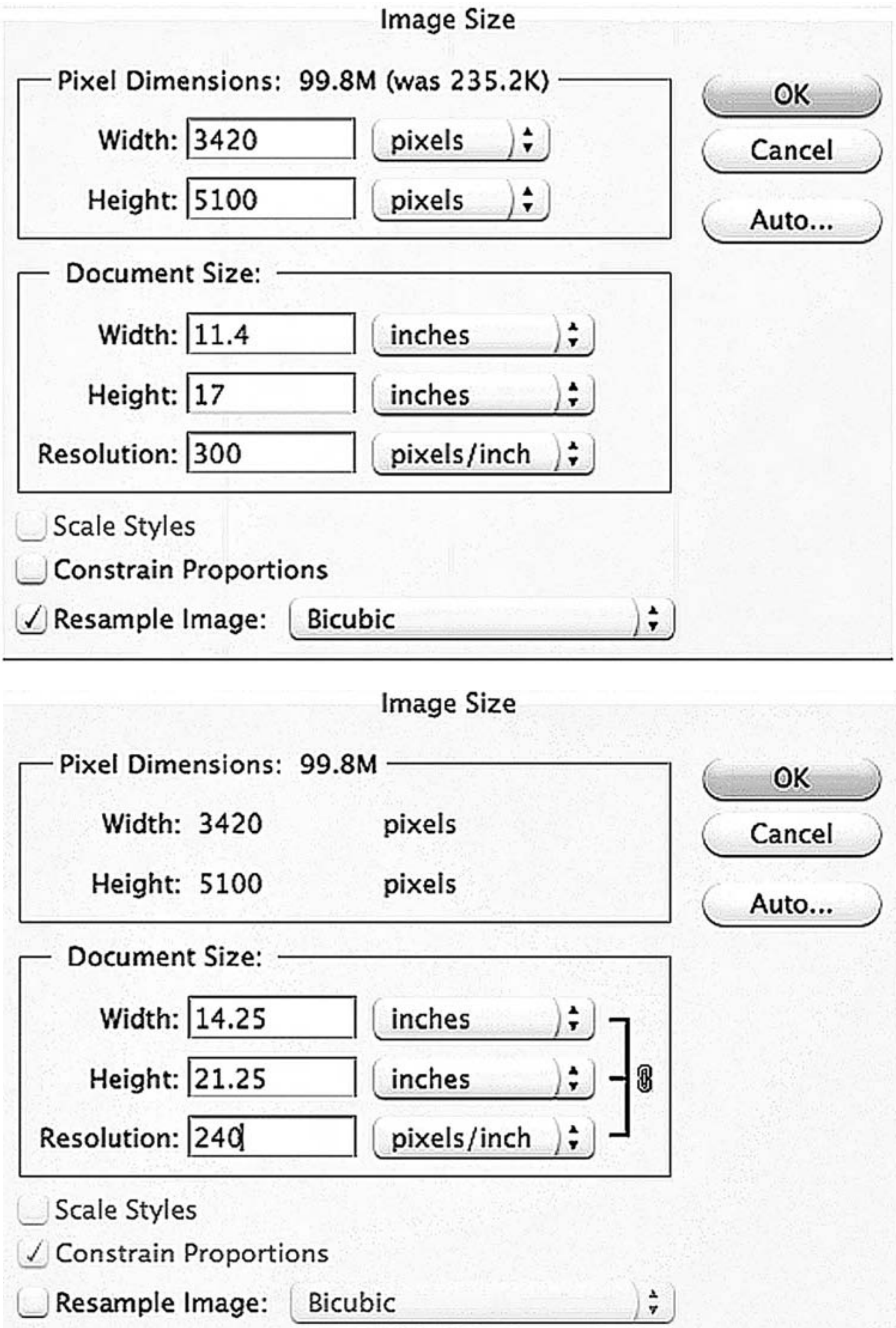


FIGURE 78 Using the Image Size box to redistribute pixels.

Figure 78(b) is the Image Size box that would result if I later changed my mind and decided that I wanted to make a larger print without compromising the quality of my photograph.

Notice that I've changed the resolution to 240, the minimum for high-quality ink jet prints but the file size is the same, 99.8 megabytes. The difference is that image pixels in the larger print will be a little bigger.

The "Resample Image" box tells Photoshop to mathematically create new pixels to replace the original ones in your image. Because that box is not checked, the same amount of information is simply distributed in different ways. It would be an example of destructive interpolation if I had upscaled the image's file size.

- **File Size Calculator.** It's sometimes necessary, or just interesting, to know what total file size will result from a given combination of image settings. Adobe Photoshop has a feature that essentially functions as a file size calculator that instantly accounts for all of the variables we've been discussing.

In Photoshop if you select File > New the following box will appear.

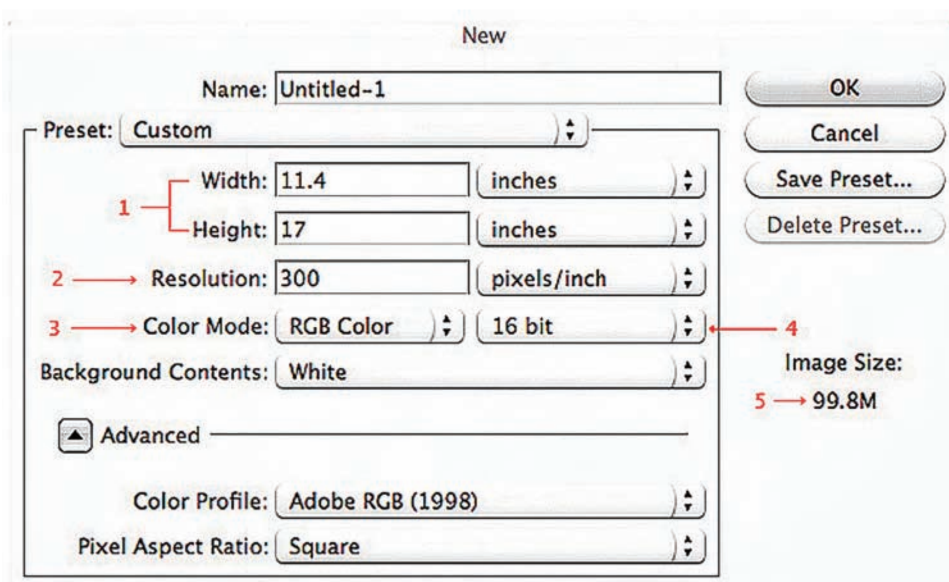


FIGURE 79 Photoshop New Box as a file size calculator.

Notice that all of the image quality settings are present.

1. These are the dimensions of the largest print I plan to make from this file. The drop down menu also gives me the option of displaying this as the equivalent number of pixels.
2. 300 dpi is the standard resolution for high-quality ink jet prints. 240 and 360 are other possible choices.
3. This setting shows that I will have three color channels in this image.
4. 16 bits per channels will allow for editing without degrading the image. When this file is ready to print I would change the mode of this image to 8 bits per channel,

which would reduce the file size by 50%. There's no quality advantage to sending more than 8 bit files to the printer.

5. This is the total file size that results from these settings.

Summary

Pixel resolution, bit depth, and the image's total file size are Core Digital Values that together determine the quality of the final print you can make from a given digital image file.

The following guidelines will ensure that quality of your work is as good as it can possibly be.

1. Always carefully consider the ultimate goal of your project.
   - If your intention is to make a fine ink jet print, the key factor to consider is the size of the largest print you plan to make.
2. Always capture your images at the highest bit depth possible to facilitate image editing.
   - For digital cameras this means shooting in your camera's raw format.
   - For scanned images this means choosing the highest bit depth allowed by your scanner.
3. Always scan your image at the resolution that is optimal for the final result you are intending.
   - For ink-jet prints this should either be 240, 300, or 360 dpi.
   - For offset printing this is 600 dpi.
   - For Web-based images 72 dpi is sufficient.
4. After you have edited your high bit depth image you can reduce it to 8 bits per channel before sending it to your printer.

Learning how to appropriately maximize the resolution and bit depth of your images is important, but we now need to consider the role that proper exposure plays in this process.

Bit Depth and Digital Exposure

It's often hard to believe that beautiful digital prints are ultimately created from numbers that could just as easily be printed out in undecipherable rows and columns. Nothing demonstrates this fact more clearly than the issues of bit depth and exposure with digital cameras.

Earlier in this book we learned how the Zone Scale functions as a bridge between the meter numbers we use to measure subject values and contrast, and the tonal values of fine photographic prints.

In digital photography the same role is played by something called the Histogram.

Understanding Histograms

Recall that bit depth is a measure of the number of different tonal values that a pixel is allowed to be in a digital image file. The more distinct tonal levels there are in an image, the more photorealistic it will look.

But, it has been demonstrated experimentally that only 200 individual tones are enough for human beings to believe that they are looking at a continuous-toned reproduction.

This is like saying that, if a mural artist were given little tiles that had 200 different tones she could create an image that looked like this.

FIGURE 80 Adequate bit depth illustration.

But if she only had tiles that had 100 different tonal values she would have to make a mural that looked like this.

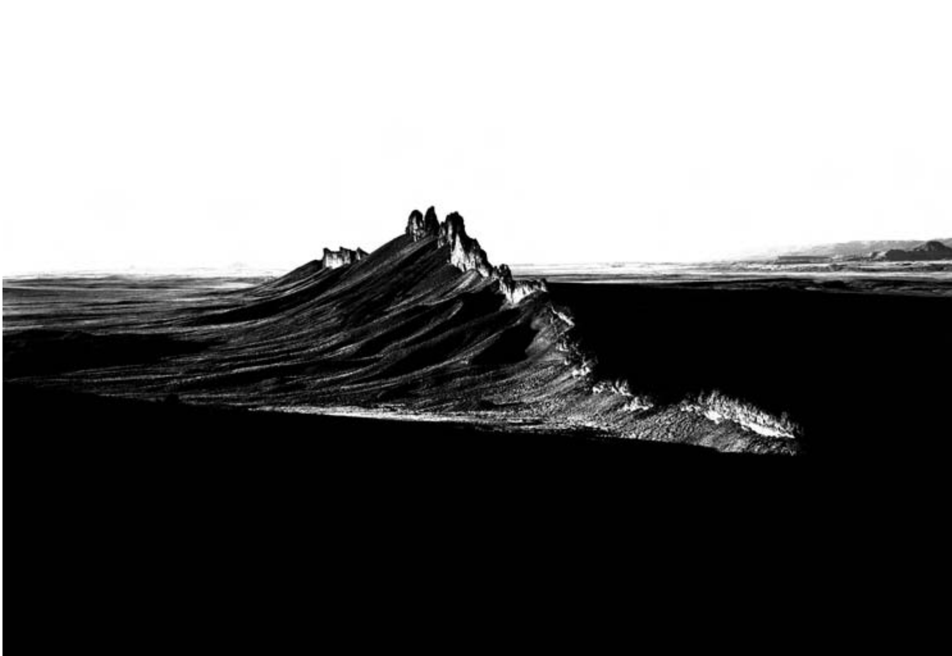


FIGURE 81 Low bit depth illustration.

The harshness and lack of subtlety in Figure 81 is the result of the limited number of pixel tonal levels in the image.

This leads directly to the question of how bit depth is accounted for in digital photography. For most digital editing purposes, the minimum standard for quality is what is called an "8 bit" image where each pixel can be any one of 256 tones from black to white. (See Appendix C for an explanation of what 8 bit means numerically.)

In Adobe Photoshop histograms these individual pixel tonal levels are numbered from 0 for the blackest possible pixel to 255 for pure white pixels. This again is like having a choice of 256 values of tiles to choose from when you are building a mosaic mural.

The pixel levels in digital images are organized into layers that are called "channels." An 8 bit black-and-white image has one channel called "Gray" with pixels that can be any of 256 different levels of tone.

FIGURE 82 Gray Channel with 256 pixel tonal levels.

Color digital images have three channels — Red, Green, and Blue — that are combined to create mixed colors. In 8 bit color images, each of these channels also has pixels that can be 256 levels of the red, green, and blue colors. This adds up to about 16.7 million different color possibilities. (256 × 256 × 256).

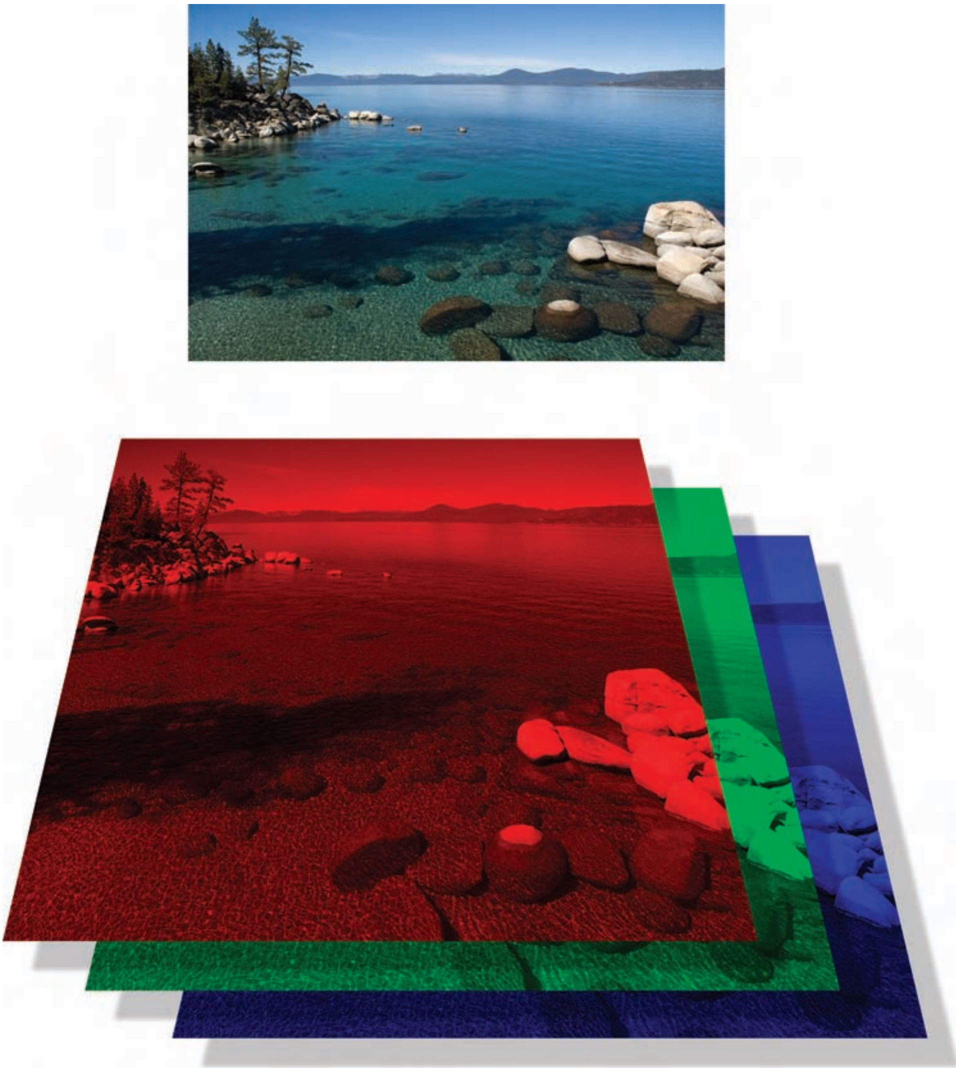


FIGURE 83 Color Channels with 256 pixel tonal levels each.

To understand how histograms come into being from all of this, imagine how it would look if we took a black-and-white image and selected 256 of its differently toned tiles (pixels) and laid them down in a line with the darkest one on the left and the lightest one on the right.

For Figure 84 I've drawn this line of tiny pixels above the familiar 10-step Zone Scale, but remember that there are actually 256 sections or "Tonal Levels" in the histogram line.

If someone were to ask you which pixel in this line is exactly the same tonal value as a specific tone of gray in a digital photograph, you could measure that spot with a device designed for that purpose and it would give you the exact pixel reading you were looking for. If the print value in question happened to be middle gray, its pixel value number would be 128 or half way between 0 and 255.

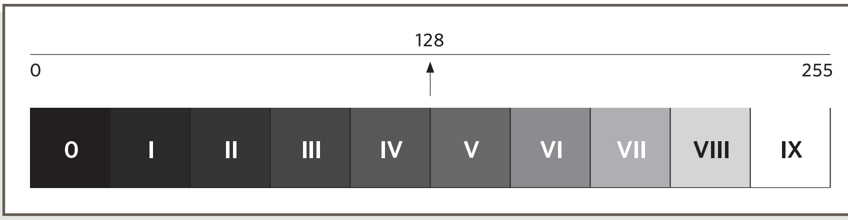


FIGURE 84 256 pixel tonal levels and Zone Scale.

If you then wanted to illustrate *how many* pixels with the value of 128 there were in that image you would draw a tall line if there were a lot of pixels with that tonal value, or a shorter line if there were only a few.

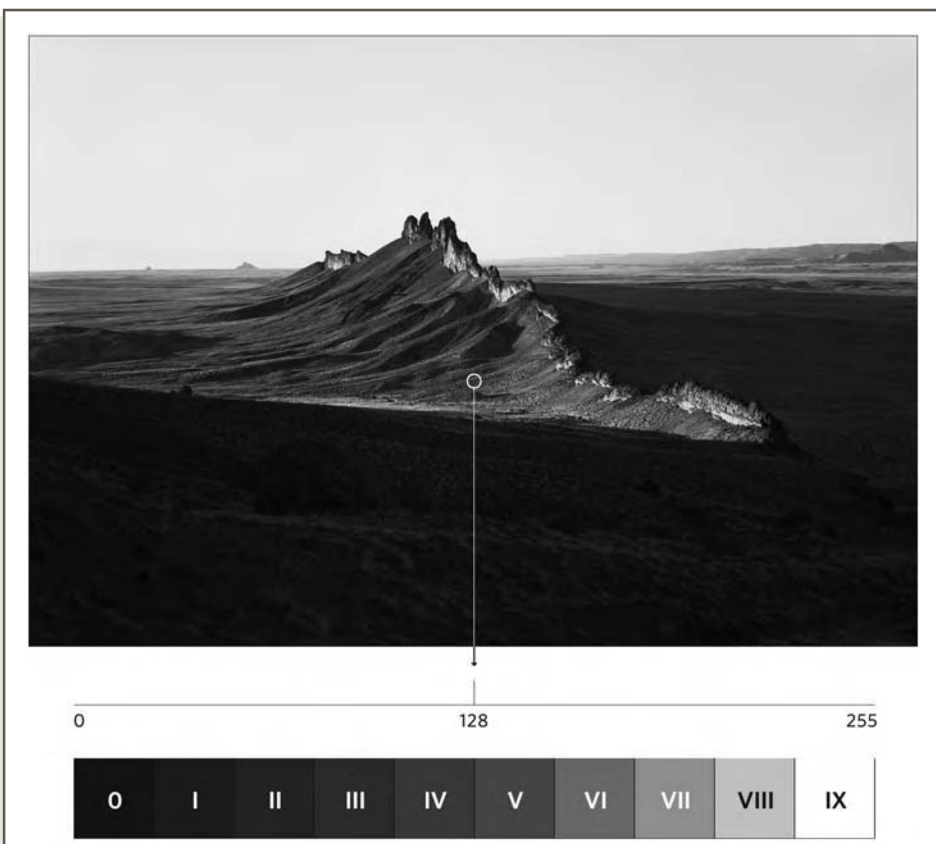


FIGURE 85 Pixel level 128 identified.

In this way, a complete graph of all of the pixels of this image would give you a histogram that looked like Figure 86 when viewed inside of the Levels Command dialog box of Adobe Photoshop:

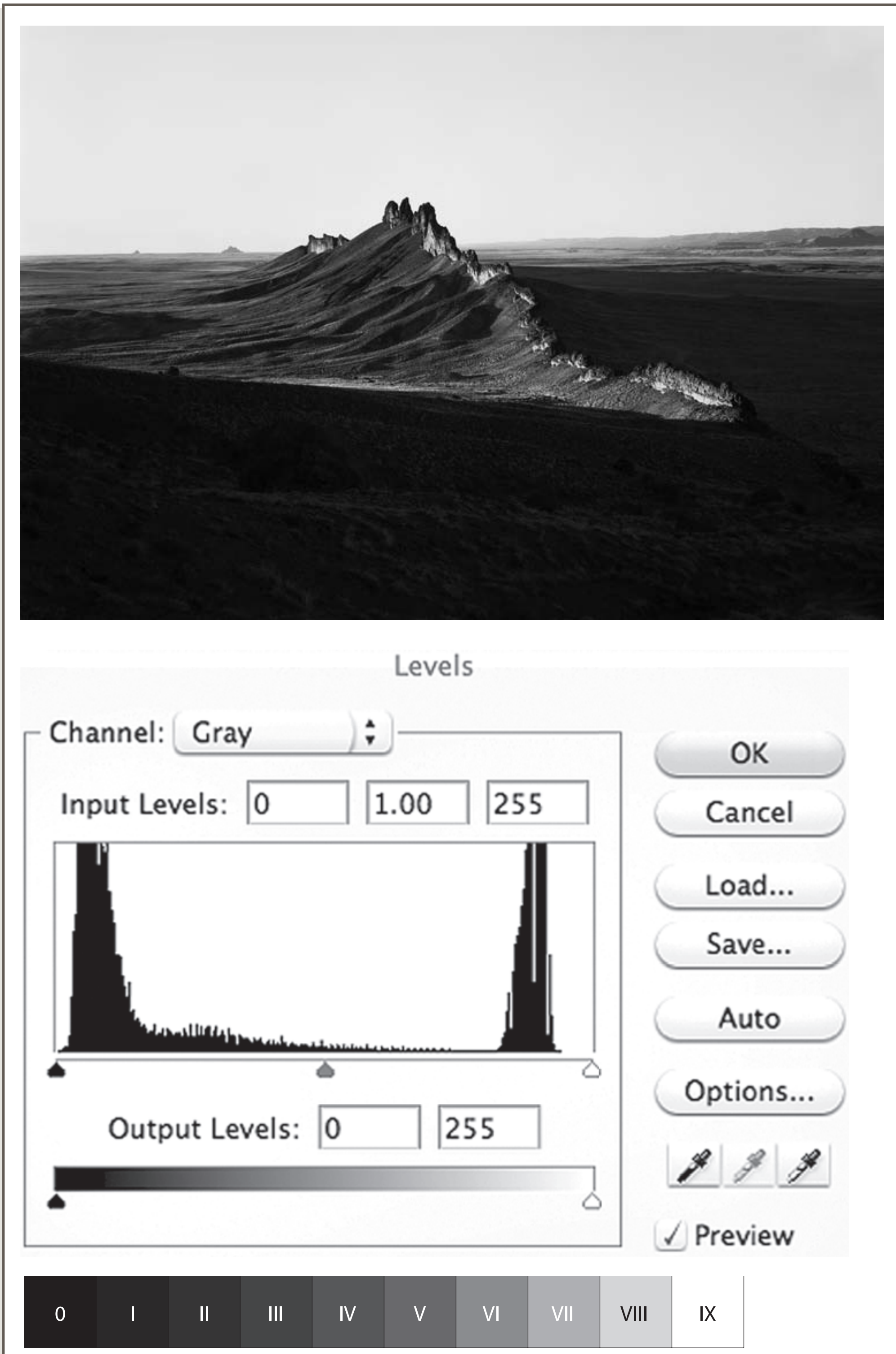


FIGURE 86 Digital histogram in Photoshop's Levels Command.

Notice that the Levels box has three pointers along the bottom: Black, Gray, and White. These pointers are sliders that, by default, point to pixel levels that are numbered as 0, 128, and 255, respectively. (The middle Input Levels box reads 1.00 because it's a measure of image contrast known as Gamma.)

If a given pointer is below empty space in the histogram that means that no pixels in the image have these values.

What this histogram is telling us is that the image in figure 86 has:

- No pixels that are pure white
- Only a few pixels that are pure black
- Many of the image's pixels are dark
- Many of the image's pixels are light
- Very there are very few pixels that are in the middle

Understanding histograms is important. Study these illustrations carefully so that what they represent is clear to you.

Stretching the Histogram

So far what we have is a static representation of the pixels in this digitized image. To understand how digital editing software tools use histograms to manipulate the contrast of digital photographs, and how all of this relates to digital exposure, begin by imagining that you are trying to reproduce a smooth, continuous gradation by drawing thin lines of tonal values on a strip of rubber. (If you think of each line as a pixel tonal level this becomes a very good analogy.)

If you use enough lines of tone and apply them very carefully, it's possible to create a convincing illusion of seamlessness.

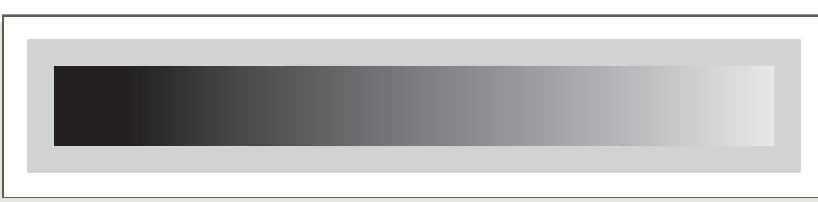


FIGURE 87 Digital gradation on a rubber strip.

If you then wanted to increase the representational contrast of this gradation by making the lighter end white so that the two edges of this gradation were further apart, you could think of this as "increasing its dynamic range."

The simplest way to do this would be to stretch out the rubber strip as far as you wanted it to go.

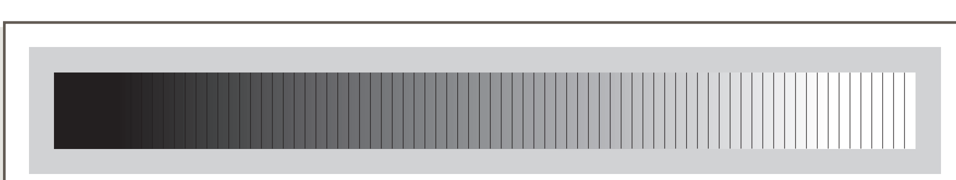


FIGURE 88 Rubber digital gradation with its contrast increased.

The contrast of this gradation is now greater. But notice that, because the rubber gradient has been stretched, this has the effect of separating the individual lines of the gradation and breaks up the illusion of continuity. The inherently digital nature of the representation is suddenly revealed.

Expanding and compressing the contrast of digital images is one of the basic functions of pixel-editing software, and when these gaps appear between pixel tonal levels in a digital photograph it's called "banding" or posterization.

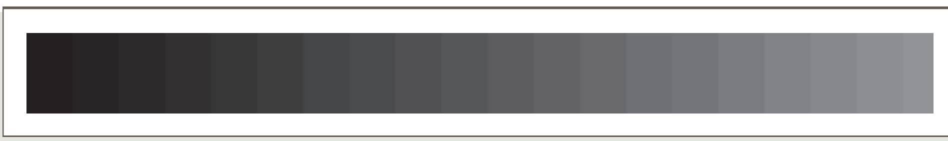


FIGURE 89 Digital banding.

Learning how to minimize this effect is an important skill for digital photographers who are trying to optimize the quality of their work.

Photographic film has no problem reproducing continuous gradations and increasing and compressing their contrast because they are seamless by nature. (Film grain isn't a factor in this discussion because even a grainy gradation still progresses from one tone to the next in a continuous, but grainy, way).

Using this illustration as a guide, the two fundamental principles that help to minimize banding makes intuitive sense:

1. First consider that the more lines you are able to draw on the rubber strip, the more even and continuous the result will be and the more stretching it can tolerate before banding appears. Higher bit depth images are much easier to edit without compromising their quality.
2. The less you stretch the rubber strip, the more the illusion of a continuous gradation is preserved.

I mentioned earlier that black-and-white JPEG 8 bit digital images allow for pixels to be any of 256 different tones from black to white. But camera raw photographs can easily be converted into 16 bit images where each pixel can be any one of 65,536 levels of tone or color! This means that you will have 256 times the number of pixel levels to work with and this makes avoiding banding much easier. See Appendix C for more on bit depth.

The second principle has direct implications for how digital images should be exposed. Here's how this works.

Our rubber gradation illustration makes it clear that the more you stretch out the tonal values of your subject, the more the image is degraded into noticeable digital bands.

The following illustration demonstrates the relationship this principle has to exposure in digital cameras.

Figure 90 shows an example of what happens when you underexpose an image that has average contrast with a digital camera.

Note: I made no contrast adjustments during the conversion from the camera raw state of the image and performed a simple translation of the original color image to an 8 bit grayscale file so that the tonal values will be consistent with my rubber strip gradation example.

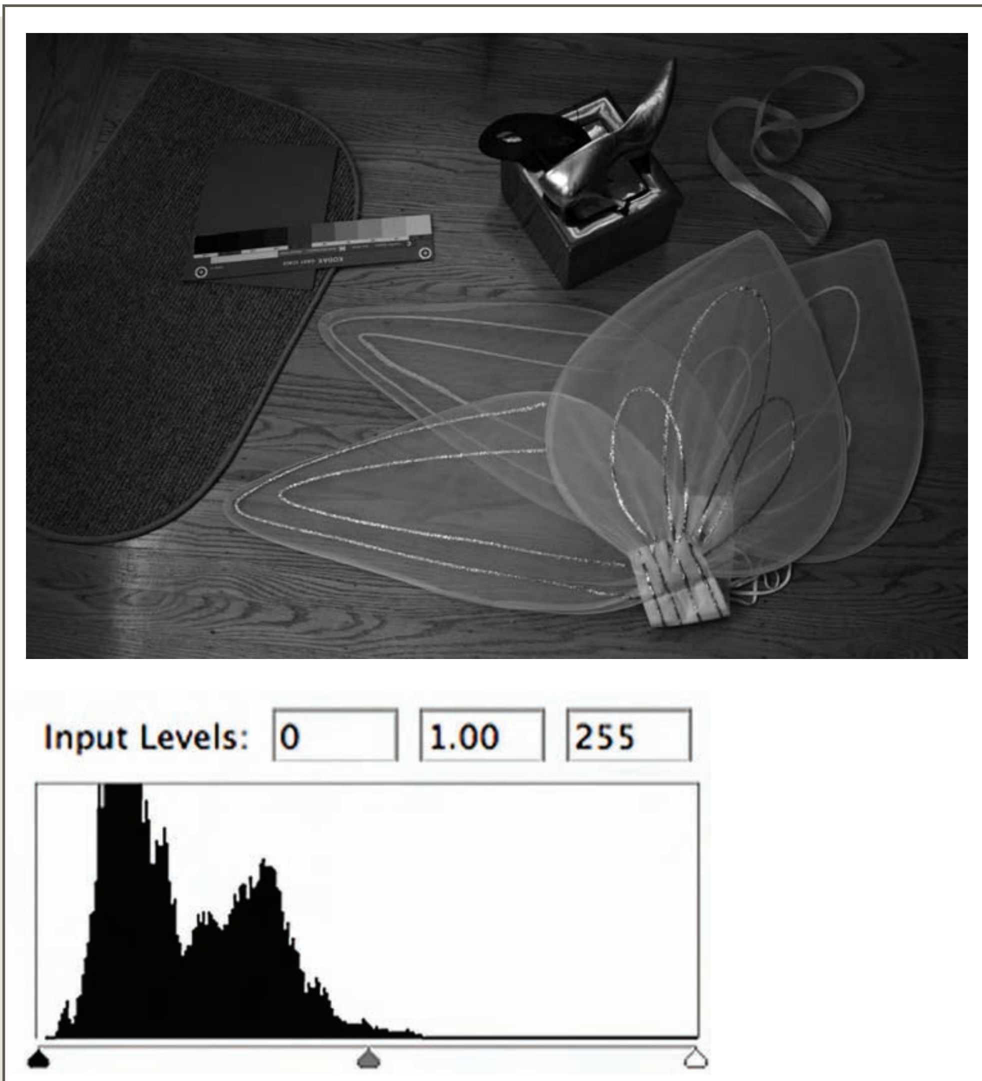


FIGURE 90 Histogram of underexposed digital image.

Because this image is underexposed, most of the pixels are clustered to the left of the histogram and the pixels that represent the lightest tonal values of the image are near the middle of the scale.

In Adobe Photoshop's Levels Command the white, black, and gray sliders allow you to change the value of an image's pixel levels in the following way.

When you move a slider to a given pixel level in the histogram, you are essentially telling the software to change that level to either white (level 255), black (level 0), or middle gray (level 128). This depends on which slider you are moving.

Think of the pointers as grabbing the pixel level it is set to and literally dragging it to either the extreme right, left, or middle of the histogram. All of the other levels in the histogram are either stretched out or compressed in relationship to these adjustments.

The preview of the image updates itself in real time to give you a sense of how the adjusted image will look.

Figure 91 illustrates a typical contrast adjustment process. The first step would be to slide the white pointer to the left until it's under the pixel value you want to be the lightest tonal value in your image.

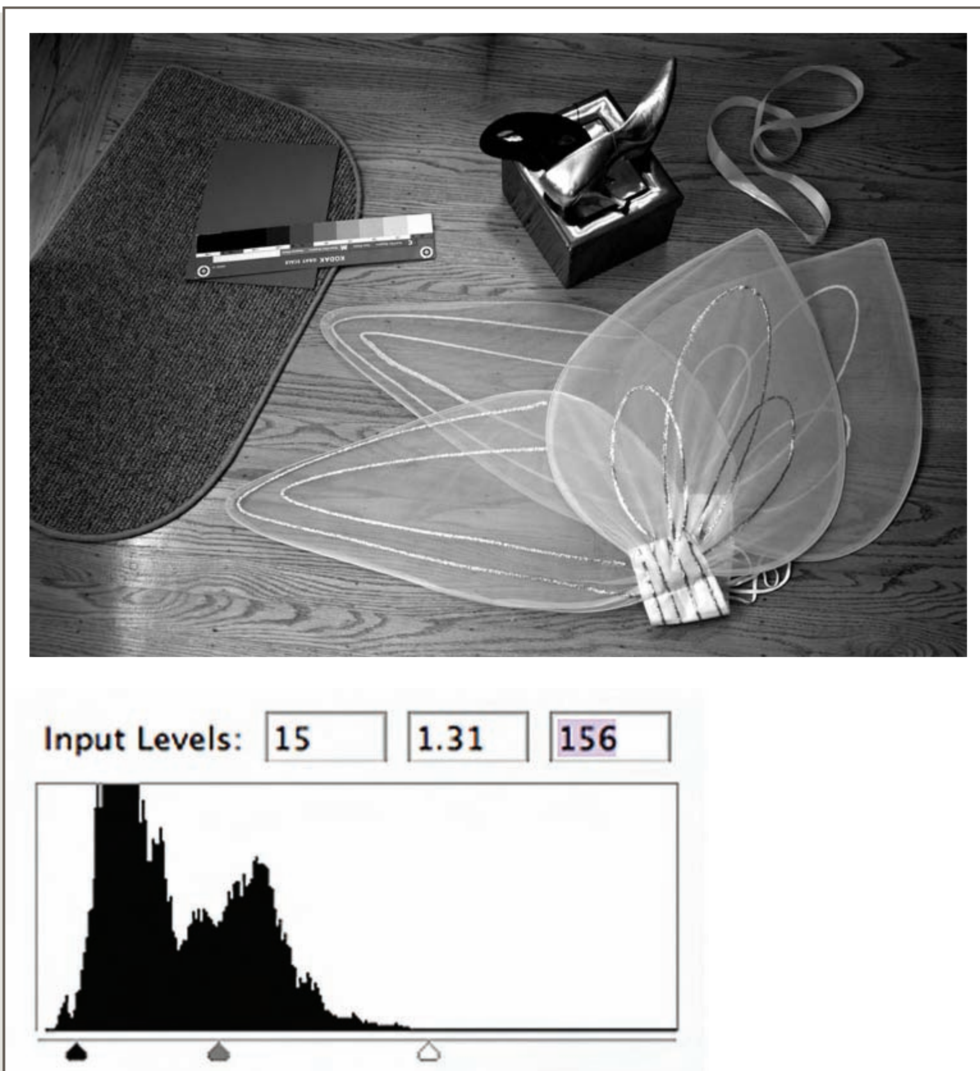


FIGURE 91 Histogram of underexposed digital image w/Levels adjustments.

In this case moving the white point slider to pixel level 141 gave the image a good range of contrast in the preview. When I click "OK" to accept this adjustment, pixel level 141 will be dragged to the right and reset to level 255. This is called "Setting the White Point."

I also adjusted the black and middle gray pointers until the image's contrast looked correct.

With this adjustment, the Levels Command stretches or compresses all of the other pixel values of the image so that they fill the complete range of tones from black to white. Figure 92 is the result.

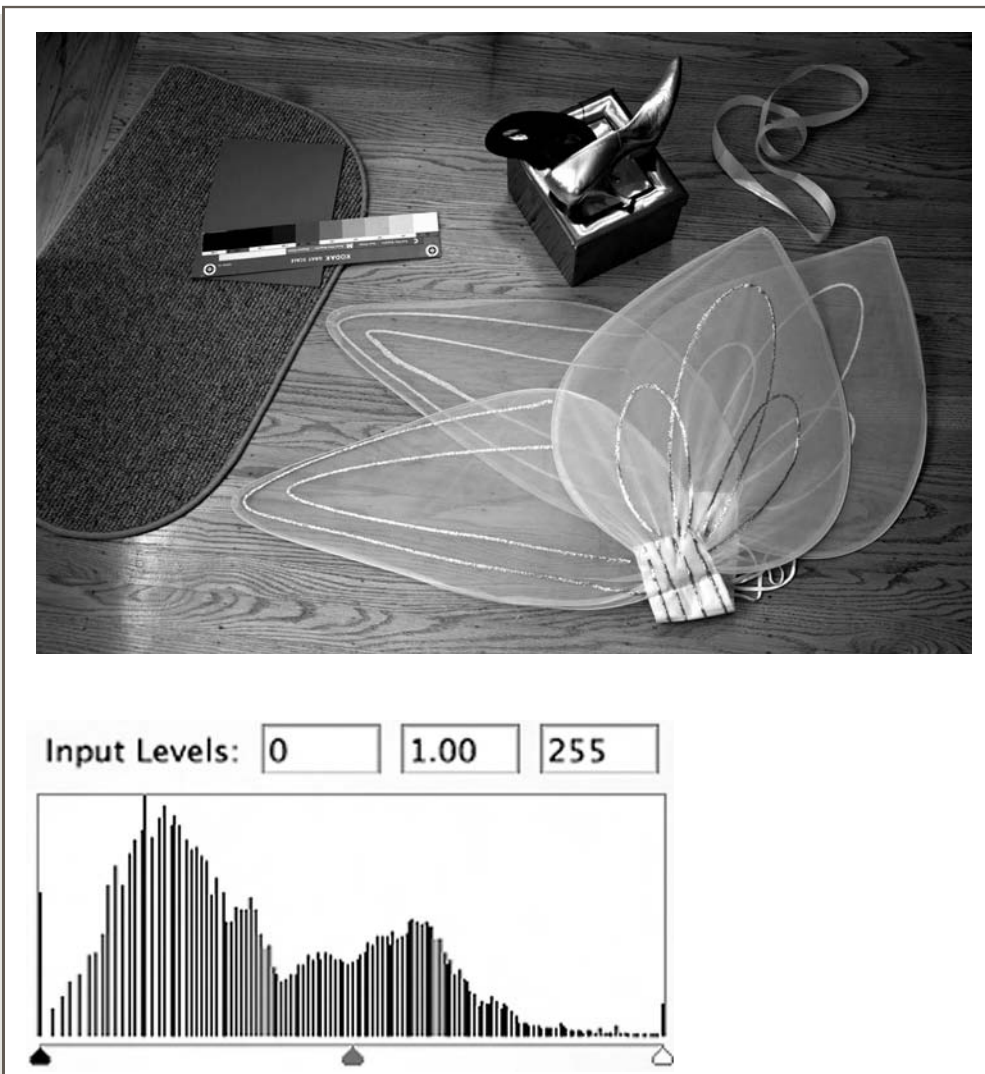


FIGURE 92 Histogram of underexposed digital image after Levels adjustments.

There are two important things to note about this example.

First, notice that when the contrast of this image is expanded, gaps appear in the histogram that indicate tonal values that aren't present in the image. Before I made this adjustment all of

the pixel levels were clustered together and the image values were more continuous. Now that the contrast has been expanded there are gaps and the digital nature of the image is more obvious.

Figure 93 shows a detail of the effect this has on the shadow areas of this illustration.

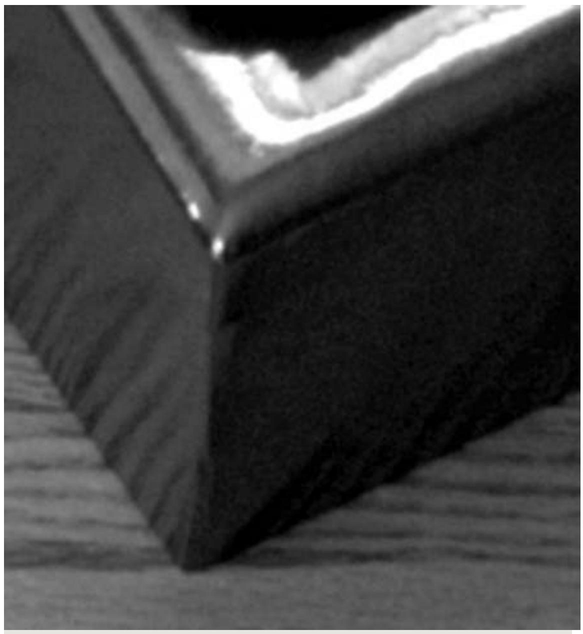


FIGURE 93 Detail of banding in an underexposed digital image.

This image was shot at ISO 200, so what looks like noise in this shadow area is actually the loss of pixel levels or banding.

Some degree of banding is inevitable when you edit digital image files, but minimizing this effect is the key to achieving the best quality in your work.

The second thing to notice in Figure 92 is that the banding effect is greatest in the darkest tonal values of your image. There are far more gaps on the left side of the gray pointer in the middle than on the right side.

The shadow values suffer the most from this process because fewer pixel levels were devoted to them in the first place. The reason for this problem is explained later in the section The Problem of Digital Shadows, and in Appendix D.

The Zone System of Digital Exposure: Exposing for the Highlights

Exposing to the Right

The best way to minimize the effects of banding in digital images is to learn how to make accurate digital exposures that place your highlights as close as possible to where they should be on the right edge of the histogram.

This is called "Exposing for the Highlights" and there are two reasons why this works. The first is fairly obvious. The second is more subtle but just as important and is discussed later in the section The Problem of Digital Shadows.

Exposing for the highlights is a valuable technique. Using the language of the Zone System, placing the Important Highlight on Zones VII or Zone VIII where they belong, minimizes the need to stretch out the image's pixel levels, which causes banding and posterization in the shadow areas.

Figure 94 shows the same image as the previous example but with an exposure designed to place the meter reading of the Important, textured white highlight values on Zone VIII. Any brighter areas of the subject are specular reflections that can be rendered as Zone IX.

Notice that when compared to Figure 91, the tonal values of this histogram are shifted substantially to the right. This is why this technique is often referred to as "Exposing to the Right."

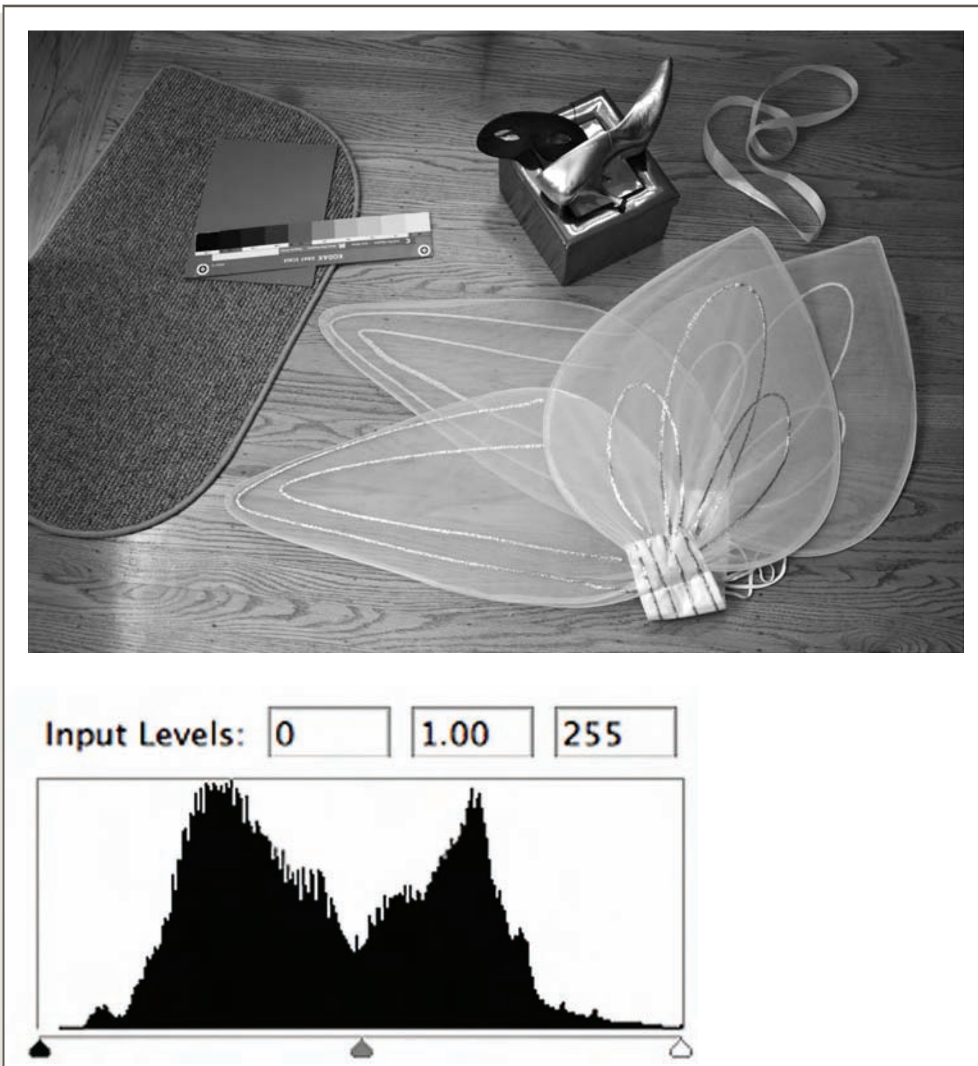


FIGURE 94 Histogram of properly exposed digital image.

Figure 95 shows the adjustments made to match the contrast of Figure 91 as closely as possible.

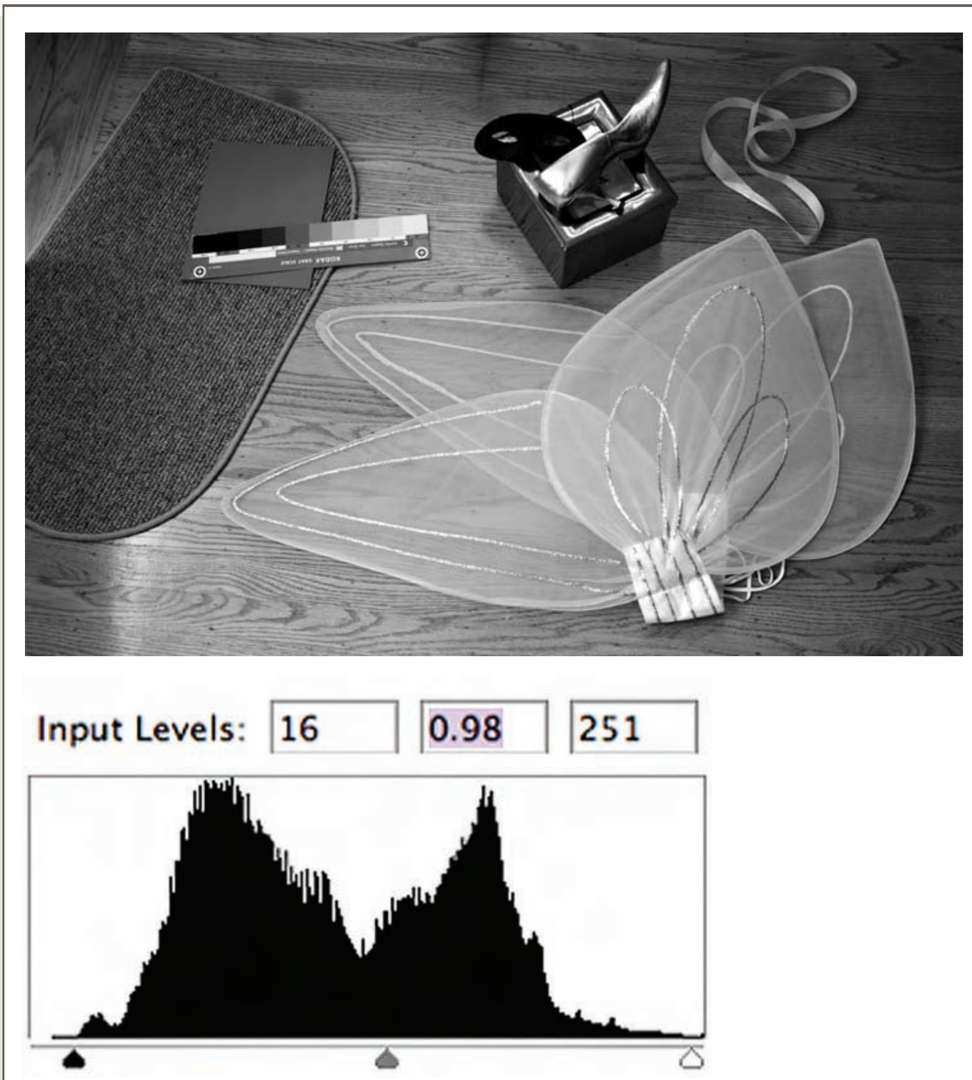


FIGURE 95 Histogram of properly exposed digital image w/Levels adjustments.

Notice that only slight adjustments of the white, black, and middle gray sliders were necessary because the exposure was correctly placed on the Zone Scale.

Figure 96 is the image and histogram that resulted from these adjustments.

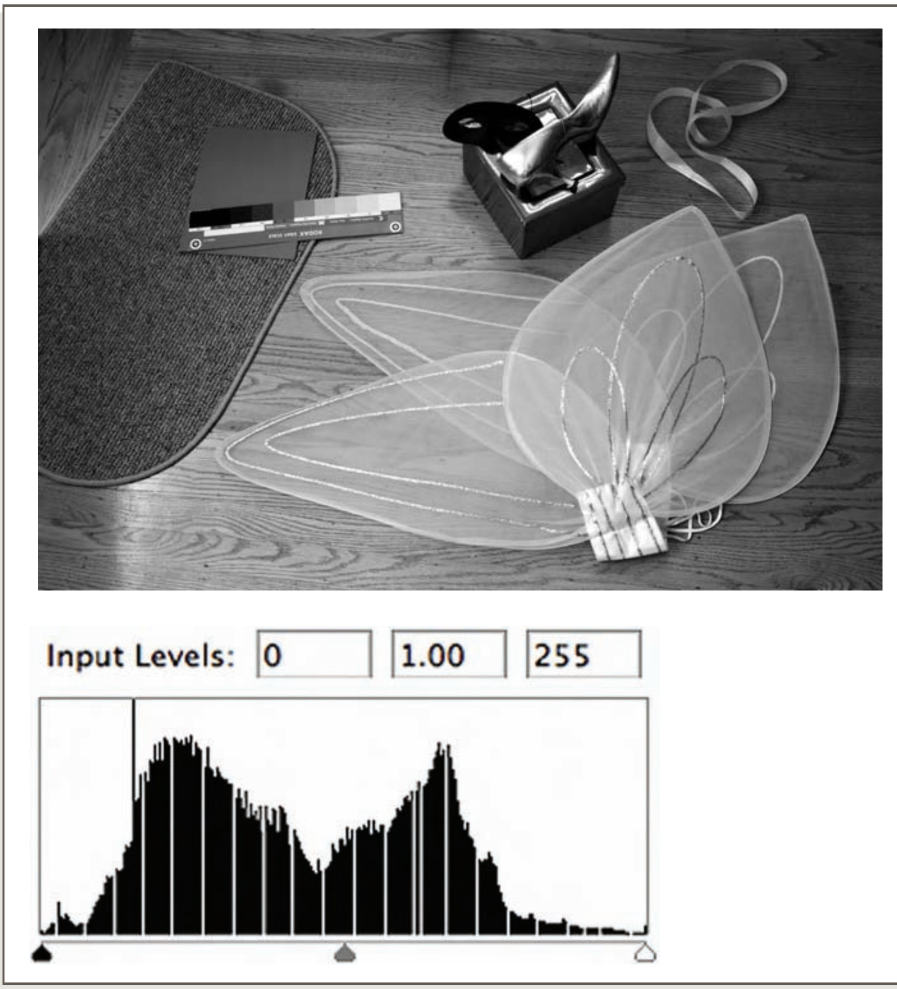


FIGURE 96 Histogram of properly exposed digital image after levels adjustments.

Note that, compared with the histogram from Figure 92 which is shown again below, there are far fewer pixel level gaps using this method and the gaps are much more evenly distributed across histogram.

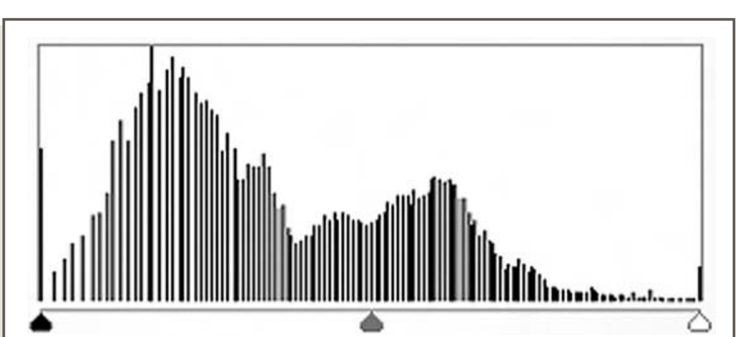


FIGURE 92 Histogram of underexposed digital image after Levels adjustments.

A careful comparison of details from these two examples shows that proper exposure greatly improved the quality of the shadow areas.

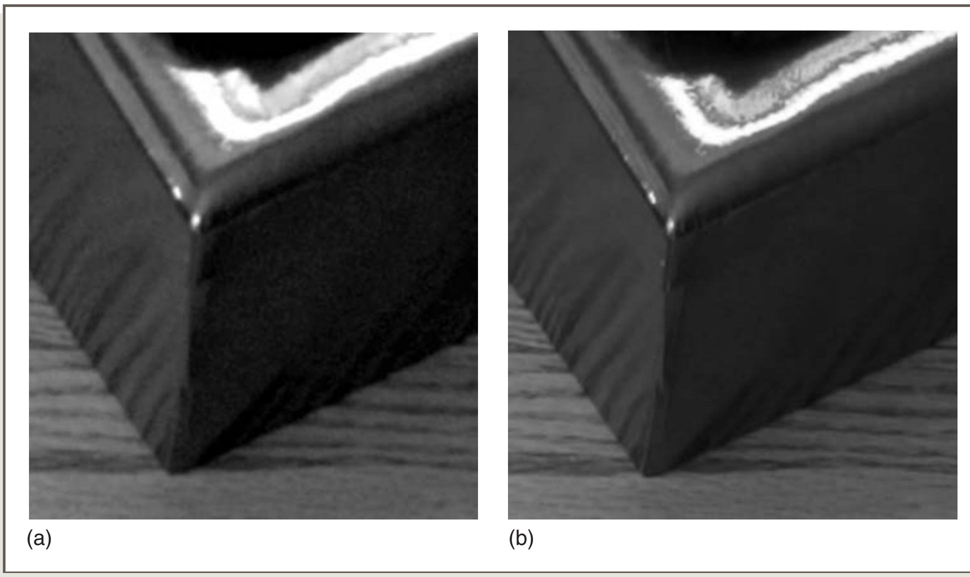


FIGURE 97 Details of Shadow of Underexposed and Properly Exposed Digital Images. (a) Underexposed; (b) properly exposed.

The Problem of Digital Shadows

The reason why this process is especially damaging to the shadow areas is because of the second, more subtle reason that I mentioned earlier.

The fact is that digital cameras inherently devote more levels of pixels to rendering detail in the highlights than they do to the darker areas of the subject.

When I introduced the illustration of the way that pixel levels could be stretched out if they were drawn on a strip of rubber, for the sake of clarity, I intentionally skipped a step in the process and illustrated it like this.

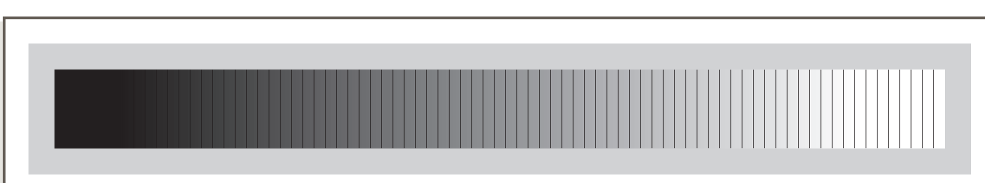


FIGURE 98 Gradation and pixel levels of a non-linear, converted digital spectrum.

This is actually the way an expanded gradation would look AFTER it had been converted from its raw digital state into a Photoshop file.

Notice that in converted files, the pixel levels that make up this spectrum are distributed evenly from one end to the other and the spectrum itself is even and balanced with middle gray in the center.

Also notice that the shadow areas are defined by the same number of levels as the middle values and the highlights.

This approximates the way our eyes perceive light, but it isn't at all the way digital cameras record shadow and highlight values in unconverted raw files.

A more accurate representation of the way these tonal values and levels are distributed across the spectrum in raw digital images would look like this.

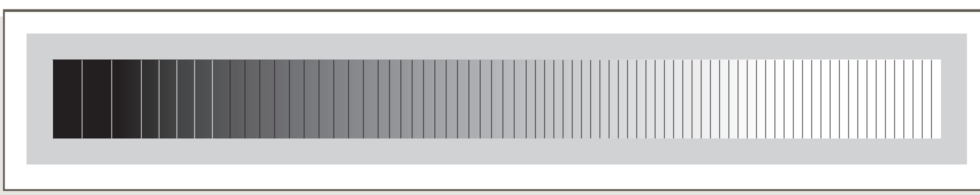


FIGURE 99 Gradation and pixel levels of a linear, unconverted digital spectrum.

Two important things are obvious in this illustration.

First, in camera raw image files, much more of the spectrum is devoted to the highlights than is true in Figure 98. Middle gray is shifted over to the left.

Second, the shadow values in raw digital images are defined by far fewer pixel levels than are the middle and highlight values.

The process of converting camera raw files into the normal formats we work with in Photoshop is called "Tone Mapping" and, as you can see, it makes a profound difference in the characteristics of the file. The reason unconverted raw files are structured this way is explained in Appendix D: Exposure and the Digital Linear Effect.

Looking again at Figure 92 we can understand that the second reason why stretching the histogram creates more gaps in the shadow areas is because there were fewer pixels levels there to begin with!

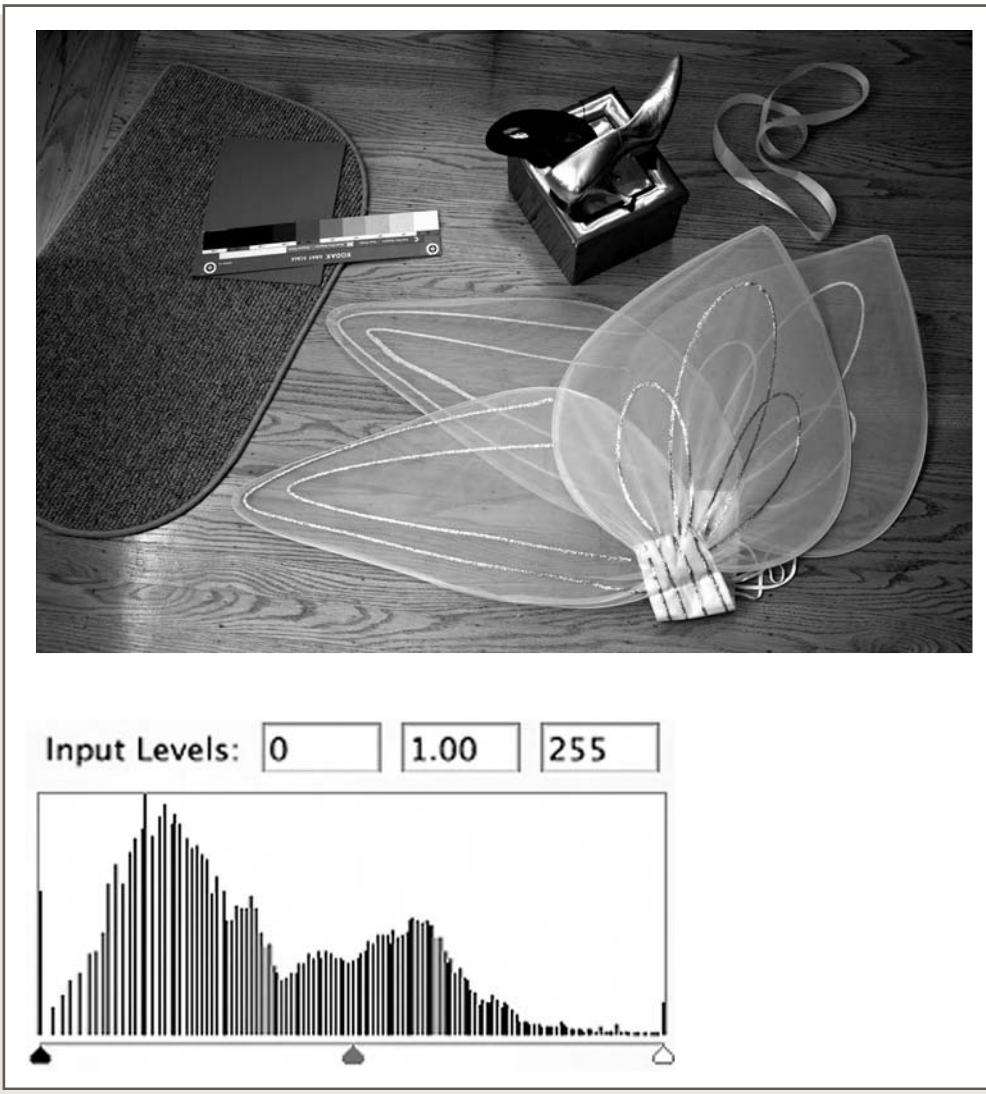


FIGURE 92 Histogram of underexposed digital image after Levels adjustments.

The way to minimize this problem is to expose your digital files so that your subject's shadow areas fall as close to the middle of the histogram as possible. The further they are away from the darker end of the histogram the better.

The Zone System provides you with a simple way to achieve this.

Digital Exposing for the Highlights

It should now be clear that there are important technical advantages to properly exposing digital image files, but using the Zone System with 35 mm cameras always requires some extra efforts.

With roll-film cameras the problem always is: how to apply individual contrast control to frames that must be developed together. That isn't a problem with digital 35 mm frames, but there is still the issue of metering selected areas with built-in light meters.

Since it's so easy to preview digital photographs using the camera's little LCD window, one practical solution would be to take a quick reference meter reading of your subject and note where the histogram falls on the scale from right to left.

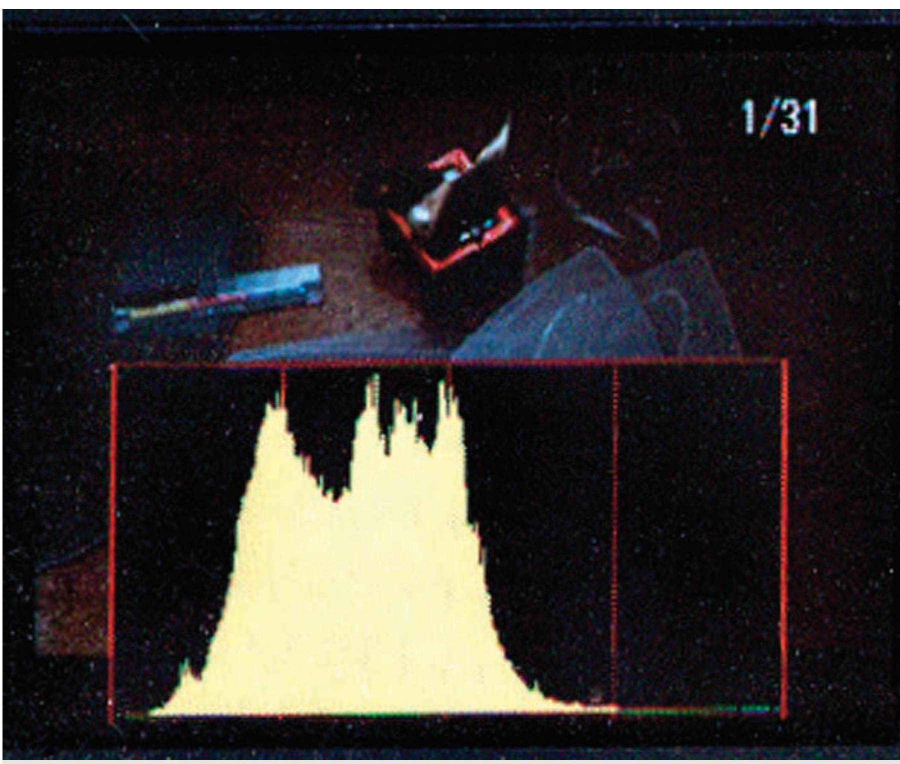


FIGURE 100 Camera histogram of underexposed digital image.

If the image is too dark you could simply open up one or two stops using either apertures or shutter speeds until the histogram is as far right as it needs to be to avoid the problems caused by expanding the contrast.

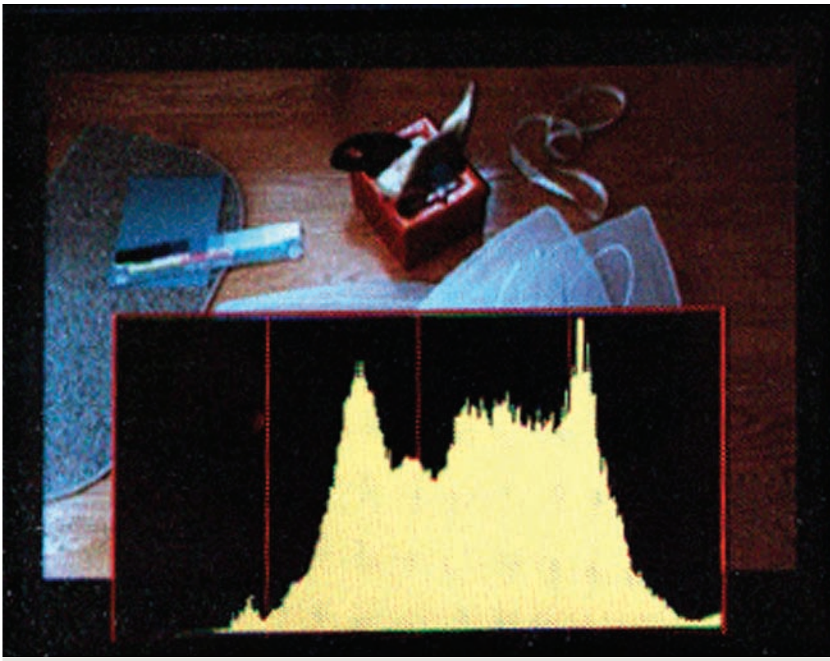


FIGURE 101 Camera histogram of digital image exposed to the right.

Moving the histogram too far to the right would be overexposure and cause the subject's highlight values to fall off the edge of the histogram where they would be lost. The consequences of this will be discussed below in the section The Zone System and Digital Contrast Control.

This is a quick and very simple exposure method (and this is what many digital photographers actually do), but there is one issue that, if you're shooting raw image files, makes this approach less precise than it appears to be.

As I mentioned at the beginning of this chapter, digital camera previews are generated based upon assumptions about how you will eventually want to use the image. One of those assumptions is that you're shooting for JPEG images that are compressed. If you are shooting in raw format, which you should be, this means that the histogram the camera creates won't precisely match the one you will eventually be working with. This issue also applies to the flashing "out of gamma" highlight warnings that are a function of many digital SLR cameras. When your preview is set to this function it can give you the alarming impression that your highlights are blown out when, if you are shooting in raw format, they may be recoverable.

A more precise exposure approach would be one that accurately placed your subject's highlight values where they should be on the Zone Scale. Photographers who are experienced with properly exposing transparency films are very familiar with this variation of the Zone System, which is much more accurate and consistent.

If your in-camera light meter has a spot metering function, or if you have a hand held spot meter:

- Carefully meter the Zone VII Important Highlights of your subject.
- Make note of the meter's recommended exposure for these areas.

FIGURE 102 Meter's recommended exposure-Zone VII on Zone V. Remember that the meter's recommended exposure would render these areas as Zone V or middle gray.

- Since Zone V is two stops darker than Zone VII, opening up two stops from the meter's recommended exposure for the textured highlight will accurately place them on Zone VII.

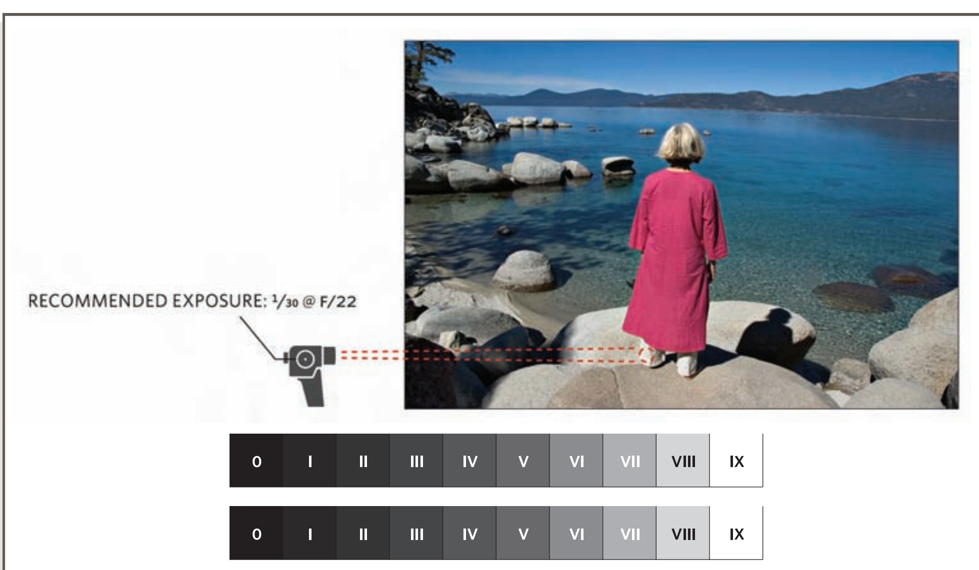


FIGURE 103 Important Highlight placed on Zone VII.

This will be the perfect exposure for digital cameras!

Chapters 4 and 5 explain the general theory behind this process in great detail.

With compressed 8 bit JPEG photographs you have relatively few pixel levels to work with so the editing required to correct bad exposures can seriously degrade your image.

Although this Zone-System-oriented approach to digital exposure will work extremely well with JPEG images, it's important to not overstate the importance of using this method when you're shooting camera raw files for your general purposes.

As you will see, the conversion process from raw files to tone mapped digital images offers you many powerful tools for manipulating the exposure and contrast of your photographs.

Adobe's Camera Raw converter allows for effective exposure control that can, to some extent, compensate for exposure and contrast problems.

What the Zone System adds to this process is the ability to make consistently precise exposures that require less correction in the conversion stage; it allows you to think creatively about how to use exposure in imaginative ways.

A Summary of Digital Exposure Effects

To summarize what we have learned about digital exposure:

1. It's important to shoot using the lowest ISO that is practical in a given lighting situation. This will minimize the noise in your images. The higher the ISO, the more noise there will be in the shadow areas of your images.
2. You should always shoot in camera raw format unless you're sure you will never need the extra bit depth that this setting provides. This will give you many more pixel levels to work with when you're editing your photographs.
3. Underexposure of digital images results in a histogram that has its pixels clustered to the left where there are inherently fewer levels defining the shadows of your subject.
4. This requires you to stretch out the histogram to enhance the image's contrast, which causes banding that has its greatest effect on the shadow values of your subject.
5. The solution is to **Expose for the Highlights** which reduces the need to expand the image's contrast and minimizes banding in the shadow areas.
6. Properly applied, this method will leave you with digital files that are ideally suited for the contrast control methods, which are described in the next section of this chapter.

The Zone System and Digital Contrast Control

In Chapter 2, I used the myth of the ancient diabolical innkeeper Procrustes as an analogy for how the Zone System allows you to modify the contrast of your negatives so that they print well on the grade of photographic paper that you prefer for your work.

The myth tells the story of how Procrustes would either stretch his unwitting shorter clients on a rack until they were long enough for his bed, or chop off their legs if they were too tall.

This is similar to the way that the Zone System allows you to systematically either expand or compress the contrast of your negatives so that they match the "Procrustean Bed" of your chosen photographic paper grade.

Here's a quick review of how this process works.

The first step is to carefully meter the subject area that you want to be Zone III, dark with full texture and detail.

We have learned that light meters always recommend exposures for what they see that will print Zone V or middle gray. Therefore, if we were to use the meter's recommended exposure for this area, the negative would be overexposed by two stops.

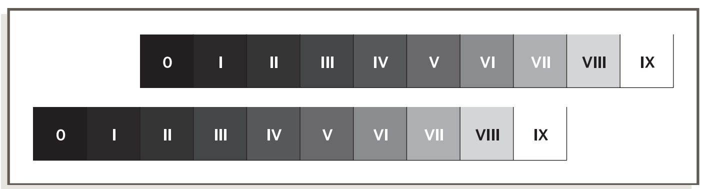


FIGURE 104 Zone V placement of an area previsualized as Zone III.

Stopping down two stops will place the meter reading for the area previsualized as Zone III on Zone III where it belongs. If, as in this example, the Important Highlight Falls on the appropriate Zone149149 then the negative would receive Normal Development.

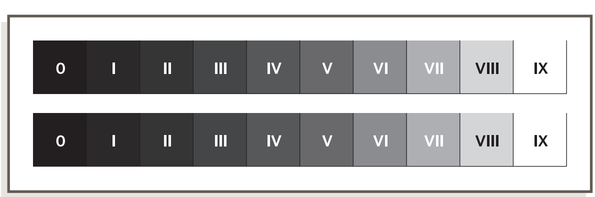


FIGURE 105 Zone III placement of an area previsualized as Zone III.

If the Important Highlight reading Falls too low on the Zone Scale we would need to increase the development time to stretch the contrast of the negative until it matches the paper's tonal scale.

This is called N + Development; in this case, N + 2.

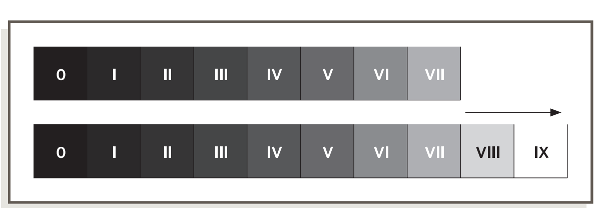


FIGURE 106 The effect of Normal Plus Two Development.

If the subject's Important Highlights Fall too high on the scale, we reduce the negative development time enough to compress the highlights until they fit properly on the scale.

This is known as N − Development; in this case, N − 2.

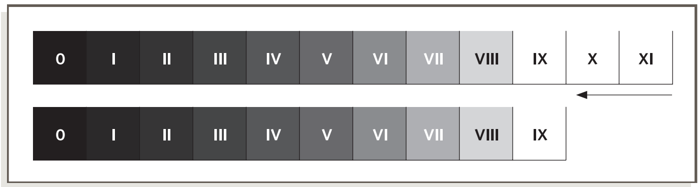


FIGURE 107 The effect of normal minus two development.

The reason this process works is because film is an inherently analog, continuous tone medium that, within limits, allows for the compression or expansion of negative contrast without the problems we discussed that are associated with digital processes.

Many photographers have had the experience of seeing a negative that has detail in highlight areas that's visible when viewed against a strong enough light source, but simply won't print on contemporary photographic papers.

This demonstrates that the detail was present in the latent state of that image and could have been rendered printable if the development time had been correct.

Digital imaging processes behave in a very different way.

The Limits of Digital Photography

Digital and film photography share one common goal: to capture as much subject information as possible so that it's available to work with when you make your finished print.

In film, severe underexposure results in shadow detail that's lost in clear, empty areas of film. Extreme overdevelopment creates highlight film densities that are opaque and print as empty pure white areas.

Similar problems exist in the world of digital photography, but the causes and terms we use to describe them are different.

Underexposed digital images aren't only dark and lack shadow detail, they also have dark tonal values that are contaminated with "noise" or random patterns of bright and colored pixels that degrade the quality of the image. This is especially true when you shoot digital photographs using higher ISO ratings like 800 or 1600.

This means that with digital materials you have to be concerned with both your shadow areas being too dark and lacking detail and with noise as an aesthetic factor.

For this illustration I have made the shadow area lighter to make the noise more visible.

FIGURE 108 Digital noise in a high-contrast image.

At the other end of the scale, film is generally more forgiving when it comes to recording high-contrast subjects.

The ability of an imaging medium to record subject contrast is called its Dynamic Range. Dynamic range is usually measured in the number of f/stops you can increase your exposure before the medium stops recording a visible difference between one stop and the next.

Black-and-white and color negative films have a dynamic range of about 8 to 10 stops. Currently, digital imaging sensors have a dynamic range that is closer to that of color transparency films, which is 6 to 8 stops.

Note: Research that currently underway promises to dramatically increase the limited dynamic range of digital sensors in the foreseeable future.

We have learned that, within limits, the highlight values of a high-contrast subject can be pulled to within the dynamic range of film by reducing the development time. "Overdevelopment" means neglecting to do this.

The term overdevelopment doesn't apply to digital camera chips, but the problems caused by attempting to photograph scenes with too much contrast are just as severe as with film.

Digital images are made of pixels or individual picture elements. Texture and detail in a digital photograph is represented by a tonal difference between one pixel and its neighbors.

If the dynamic range of your subject is too great, the light from the highlight areas will be too bright on your digital chip, which causes the tonal value of one pixel to "bloom" or bleed over to adjacent pixels. This has the effect of obliterating detail in that area of the scene. The result is a bleached out white area with no useable detail.

FIGURE 109 Blown out highlights in a high-contrast digital image.

Histograms give us a very clear way to see this effect in terms that are especially appropriate for our Procrustean analogy.

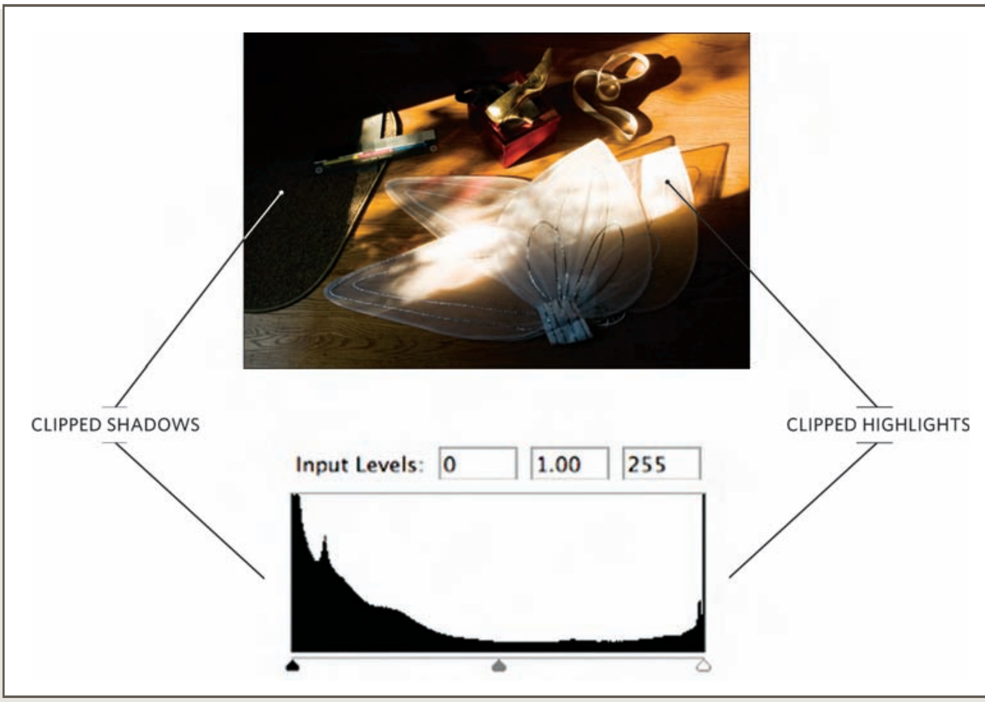


FIGURE 110 Clipping in a high-contrast digital image.

As you can see in this illustration, both the shadow and the highlight pixel values of this image end abruptly at the extreme ends of the scale.

Subject values that fall below 0 or above 255 are said to be "clipped," meaning that they are beyond the range of tonal levels that can be printed.

Once a shadow or highlight area is clipped in a digital image, the texture and detail are simply gone and can't be recovered; although there are special techniques that, within limits, can help with this problem. These are described below in the section Dealing with High-Contrast Subjects.

The Adobe Camera Raw Advantage

The process of converting a digital image from its latent state, as it exists after exposure on your camera's storage media, to the edited version in Photoshop is extremely complex and a detailed discussion of this process is beyond the range of this book.
(See Appendix S for reference to a book that will fully explain the details of working with images in Adobe Camera Raw.)

But it's important to have at least a general idea of what happens at this stage so you can make informed decisions about how to proceed.

The first thing to understand is that all digital images start out as grayscale data after the light from the lens passes through an array of tiny colored filters positioned in front of the camera's CMOS, CCD photosensitive detectors. (Foveon sensors work differently in this regard.) This means that the grayscale image data has to be converted into color information before it can be displayed.

Next, digital sensors measure light in very different ways than either film or our eyes do. Human vision responds to light in a distinctly non-linear way, whereas digital sensors simply measure amounts of photons in a strictly linear manner. The bottom line is that digital images need to go through a process called Tone Mapping before they will look the natural to our eyes (see Appendix D: Exposure and the Digital Linear Effect for a more complete description of this issue).

The important implication of all of this is that any image corrections you make at this stage of the process are fundamental and generally much less damaging to the quality of your image than editing done in Photoshop. There are also ways that you can color-correct and otherwise manipulate images during the conversion process that simply can't be duplicated in Photoshop.

This is the reason for the next cardinal rule for digital photographers:

Do as much image correction as possible during the raw conversion stage before editing your image in Photoshop.

Note: Scanners can't currently produce raw-formatted files that can be opened and edited using the Adobe Camera Raw utility. This is because scanners are creating digital images from sources that have already been through the conversion process; either as the negative or slide you are scanning, or the print made from that film. This means that the .nef files produced by Nikon film scanners aren't the same as the raw files captured by Nikon digital cameras.

Appreciating the importance of the raw conversion process leads directly to the question of what software you should use to do this. There are two general choices.

Every manufacturer of digital cameras offers proprietary software specifically designed to convert their raw files. Nikon Capture NX and the Canon RAW Image converter are examples of this kind of software.

But here we come up against what I have discovered to be a very reliable fact: Camera manufacturers aren't as proficient or creative at designing digital editing software as is a company that makes this its primary business.

Added to this is the fact that all digital images eventually end up being edited in Adobe Photoshop in any case, so you are better off using software that is specifically designed to be compatible with this environment.

Custom Camera Profiles

With professional-level digital cameras, it's possible to use the manufacturer's software to apply special profiles to your images that internally modify the contrast of each photograph as you shoot. These profiles have the effect of either increasing or decreasing the image's contrast in subtle and non-destructive ways. You can even use special software to create custom profiles that you can upload into your camera for use in unusually flat or contrasty situations.

The problem with using these custom camera profiles is that you have to remember to apply them every time you are shooting a subject with unusual contrast. Also, these profiles are generalized and apply the same degree of contrast adjustment to every image, regardless of its unique characteristics.

One reason for my strong recommendation to use Adobe's Camera Raw application is that it provides one of the most practical software solutions available for the problems associated with high-contrast digital photography.

> **Note: As of this writing there are a number of excellent raw conversion applications available including Apple's Aperture, Capture One, Bibble Pro, the DxO converter, and my favorite, Adobe's versatile new Lightroom application. All of these have features that recommend them, but for the purposes of this text I will simplify this issue by referring only to the functions of Adobe's Camera Raw Utility. One reason for this is that its tight integration with Photoshop means that it allows for the establishment of a coherent workflow that's efficient. Another reason is that it simply does an excellent job and the features covered here are more or less transferable to all of the other applications.**

First of all, when you open a raw digital image with the Adobe Camera Raw software it totally disregards your camera's internal profiles and instead applies its own unique and highly sophisticated software solutions.

Because Adobe's Camera Raw utility is working with the completely linear, untranslated data from your camera's chip, it has tools that can perform subtle image adjustments that are impossible to duplicate in Photoshop itself. See Appendix D for more on this subject.

Two of the most useful of these tools are

- The Temperature Adjustment, which actually allows you to change the tungsten or daylight color balance of your image regardless of the light source illuminating our subject.
- The Exposure Adjustment, which, within limits, can reproduce the effects of increased or reduced exposure.

All of Adobe Camera Raw's adjustments are far more precise and subtle than what you can do with internal camera profiles, and also far less destructive to pixels than any of Photoshop's contrast adjustment tools.

The following two subjects utilize some of these tools to correct digital image contrast problems that you will inevitably have to deal with.

Dealing with Low-Contrast Subjects

One of photography's more reliable truisms is that, in general, correcting the contrast of subjects with relatively low contrast is much easier than dealing with high-contrast situations. This is because, if properly exposed, all of the visual information in a flat scene will easily fit within printable dynamic range of both digital chips and films and papers.

Your goal then is to increase the contrast of your image without pushing it too far. With film this is done by using the Zone System to calculate the proper development time. With digital images there are three steps to the process of correcting low-contrast images.

Step 1

The lack of contrast in these subjects means that the relatively few levels of pixels in the image must be stretched out to render them with a full range of tonal values in the final print.

For this reason, whenever possible you should scan at high bit depths or shoot your images in raw format so that there are enough pixel levels to work with in this process. The 8 bit images allow each pixel to be no more than 256 different tones or colors per channel. Most cameras provide the option of shooting in 12 or 14 bit formats that allow for either 4096 or 16384 pixels levels per channel, respectively.

Step 2

Next it's important to make sure that your exposure places the highlight reading as close to the proper Zone VII value as possible so that the available levels don't have to be stretched too far. (See the above section The Zone System of Digital Exposure for a complete description of why this is important.)

The following is a brief summary of the steps detailed in the above section Exposing for the Highlights.

- Carefully meter the Important Highlights of your subject.
- Make note of the meter's recommended exposure for these areas.
- Remember that the meter's recommended exposure would render these areas as Zone V or middle gray.
- Since Zone V is two stops darker than Zone VII, opening up two stops from the meter's recommended exposure for the textured highlight will accurately Place them on Zone VII. This will be the perfect exposure for digital cameras!

Chapters 4 and 5 of this book explain the general theory behind this process in great detail.

Step 3

If you are shooting in raw format, there is a lot you can do to correct image contrast problems as part of the conversion process to standard image formats.

The following is an example of how I used the Adobe Camera Raw Utility to add contrast to an image shot on an overcast day.

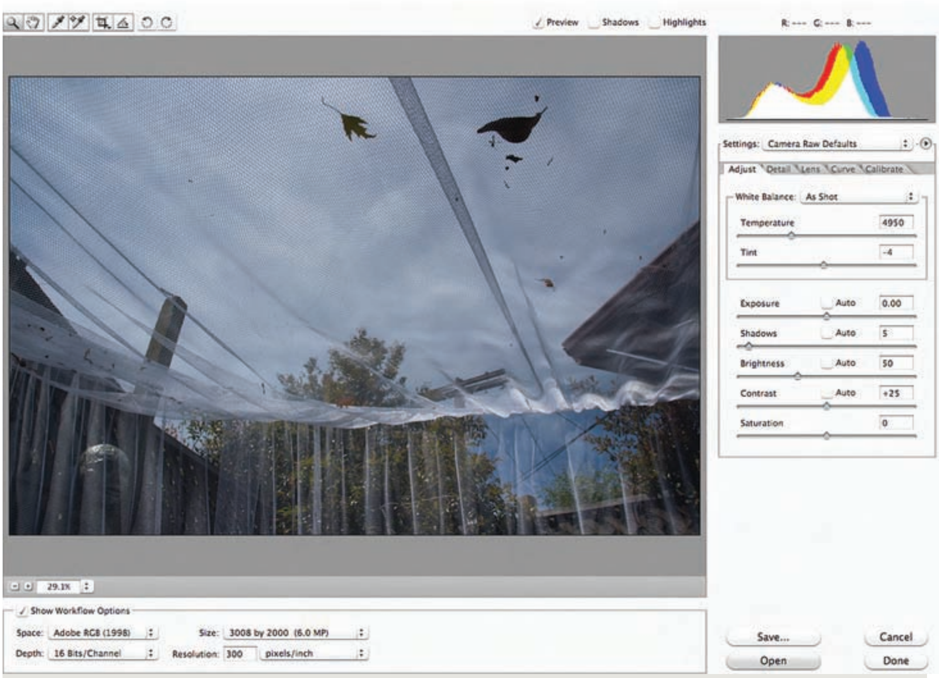


FIGURE 111 Adobe Camera Raw utility — low-contrast digital image.

The built-in histogram shows that the image's tonal values are clustered toward the middle values.

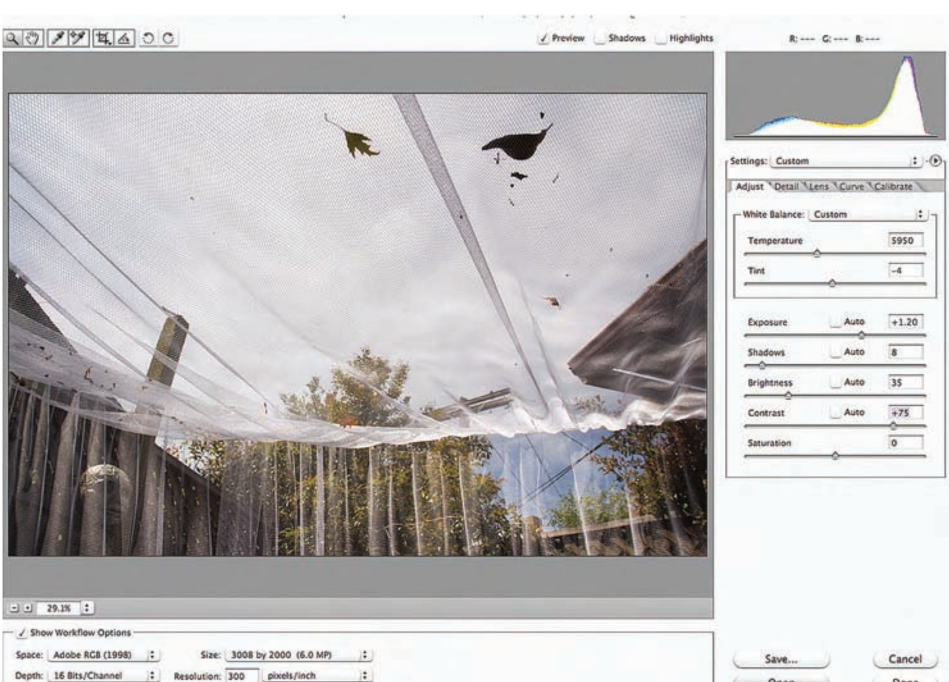


FIGURE 112 Adobe Camera Raw utility — low-contrast image adjustments.

After two quick adjustments of the Exposure and Shadows sliders, the image has a much improved range of tonal values.

It's important to take full advantage of these controls before you make adjustments to the image's contrast in Photoshop.

If you shoot your digital images in JPEG format you don't have the advantage of using these conversion adjustments.

Step 4

The above chapter section The Zone System of Digital Exposure provides illustrations and a simple step-by-step description of how to use the Adobe Photoshop Levels Command to correct the problems associated with photographing low-contrast subjects.

Needless to say, in Photoshop there are many other methods for adjusting image contrast beyond what you can do with the Levels Command. See Appendix S for a list of references to books that fully explain these techniques and methods.

Dealing with High-Contrast Subjects

Because of the limited dynamic range of current digital photo sensors, there are more special techniques and proposed software solutions to the problem of dealing with high-contrast subjects than almost any other issue in digital photography.

One very useful feature in this regard is Adobe Camera Raw's Highlight Recovery feature that is specifically designed to pull any detail that there may be in what otherwise appear to be totally clipped highlights.

For this feature to work, your highlight values can't be more than one quarter to one stop beyond the range of the histogram and there has to be room to darken your shadow values without losing valuable image information. In other words, this is a remedy for overexposed photographs that aren't too far beyond the dynamic range of your sensor.

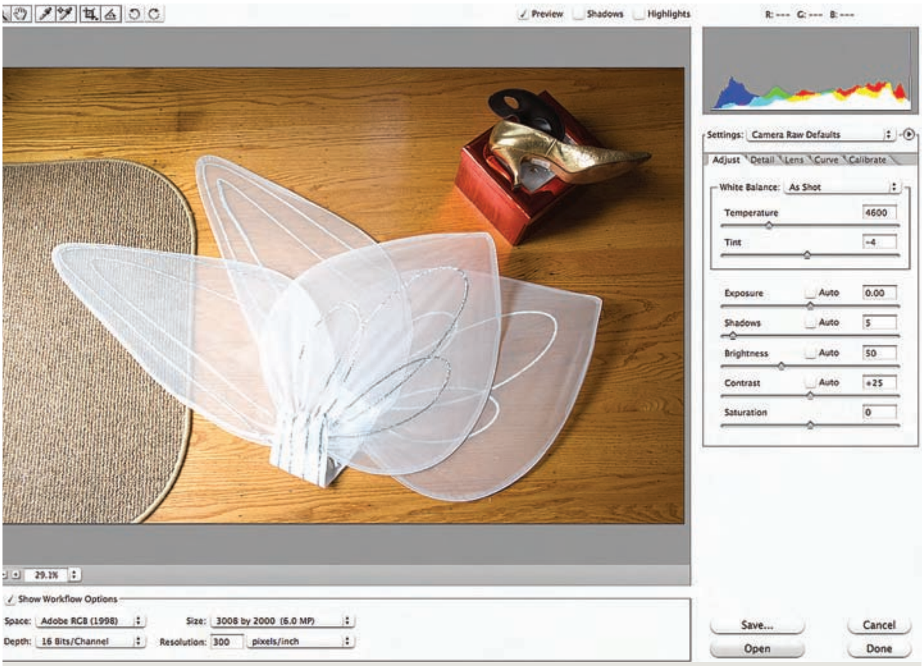


FIGURE 113 Adobe Camera Raw utility — high-contrast digital image.

The following detail shows that the highlights in this image are blown out and the red and blue spikes at the right edge of the histogram shows that these channels are clipped.

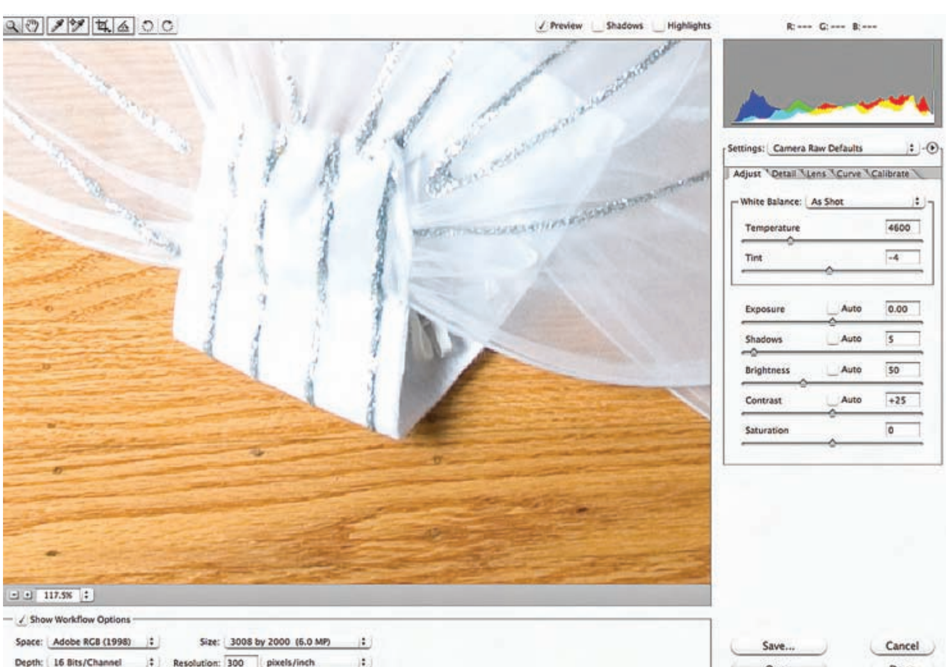


FIGURE 114 Detail — high-contrast digital image — before highlight recovery exposure adjustment.

Moving the Exposure Adjustment to the left, the image gets darker and the detail is recovered in the highlight areas.

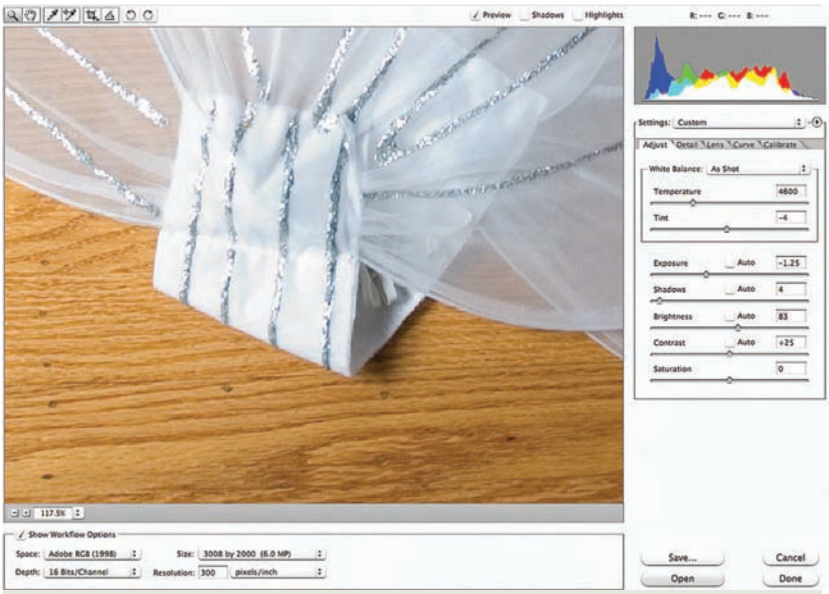


FIGURE 115 Detail — high-contrast digital image — after highlight recovery exposure adjustment.

Moving the Brightness Slider to the right and the Shadow slider to the left makes the middle and shadow values lighter but the highlights retain their detail.

After a few other small adjustments to the color temperature and saturation, the result is a greatly improved image that can now be converted into a form that can be fine-tuned and edited in Photoshop.

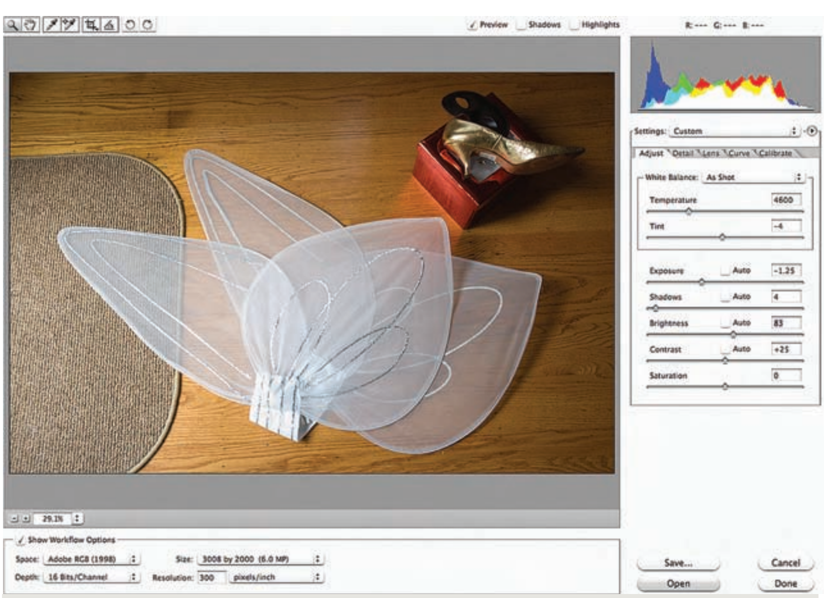


FIGURE 116 High-contrast digital image after highlight recovery exposure adjustment.

Remember that this process only works on images shot in raw format.

An Advantage of Film

In a technologically driven culture there's a tendency to believe that digital processes must have advanced solutions to all photographic problems. In very many areas this is true, but as of this writing there is one problem for which film, especially black-and-white negative materials, retains a distinct advantage.

Because of the current limitations on what the dynamic range digital chips can record, there is nothing you can do if the contrast of your subject is greater than 10 stops and **your subject or the camera is moving;** for example, if you're photographing wind-blown trees or water flowing or people walking.

There are a number of remarkable techniques that allow digital photographers to record and print an extraordinary dynamic range of tonal values far beyond what is possible with any film, but the problem is that these techniques only work well with subjects that can be shot when the camera is on a tripod and the subject is not in motion.

This amounts to a fundamental difference between digital and film photography that may help you decide to stick with one or the other. If very high contrast photography of candid, moving subjects is at the heart of your work, you may be frustrated with this limitation with digital processes.

Once again though, it's important not to overstate this issue. Fill flash techniques can compensate for this limitation and there are so many other advantages to digital photography that it's doubtful that this issue will dissuade many potential photographers.

Still life digital photographers will find the following technique extremely useful.

The Two-Layer Technique

The following is an example of an image with a dynamic range of 10 stops of dynamic range from the mask, which is Previsualized as Zone II, to the wings that I want to be Zone VIII. This is clearly far beyond the range of contrast that can be controlled using normal digital processing techniques.

FIGURE 117 Very high contrast digital image.

Here are the steps required to combine two very different exposures of this still life into one image with both open shadow areas and detailed highlights:

Step 1

Using a tripod make a series of bracketed exposures that cover the entire range of densities from far overexposed to drastically underexposed.

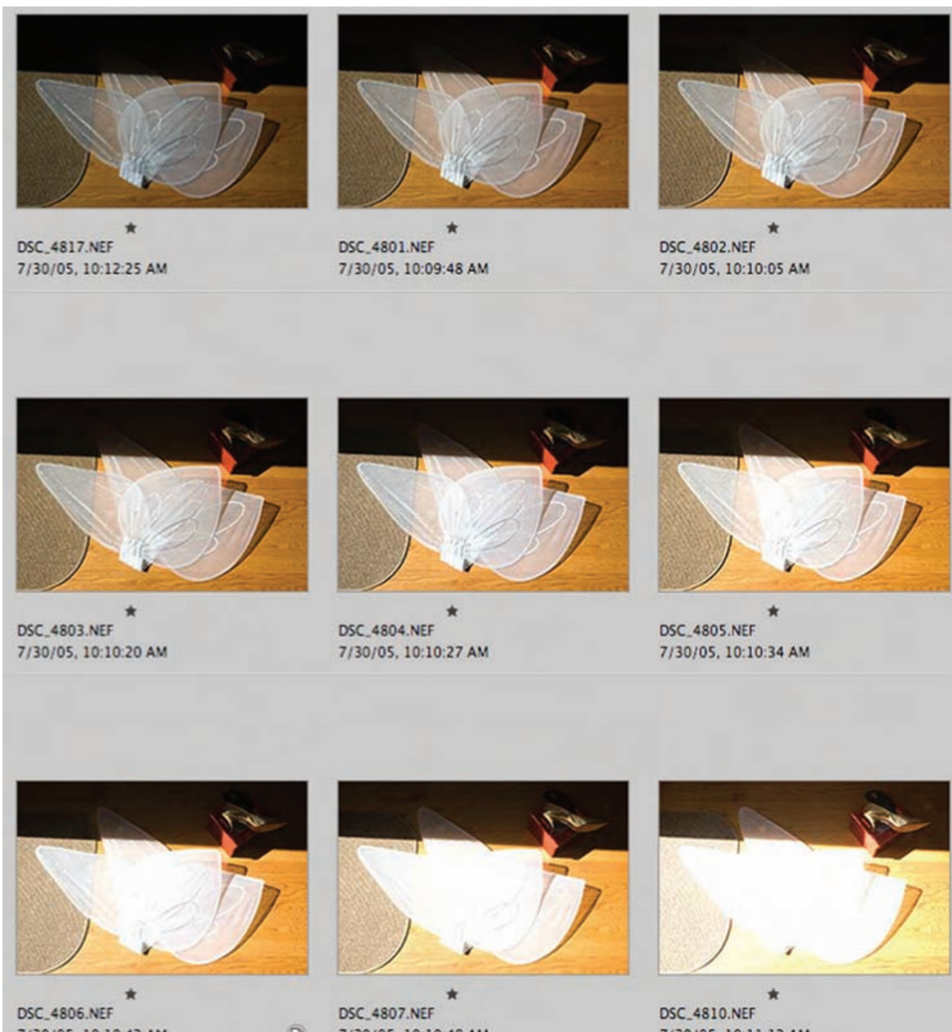


FIGURE 118 Bracketed exposures.

It's best to use your shutter speeds for these brackets because aperture brackets will change the depth of field resulting in images that will not combine as readily.

Step 2

Select the image with an exposure that has open, fully detailed shadow areas, but highlights that are totally blown out. Open this image in Photoshop. This Shadow Layer will become your Working Image file.

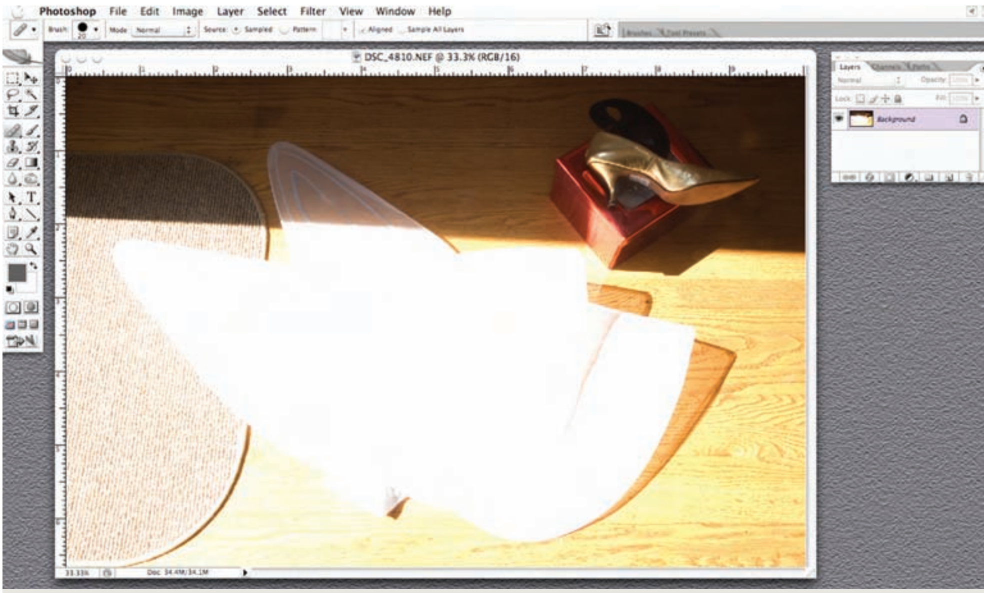


FIGURE 119 Working image file w/open shadows.

Step 3

Choose a Highlight Layer image that has well-exposed, detailed highlight values but empty, dark shadows. Open this image in Photoshop.

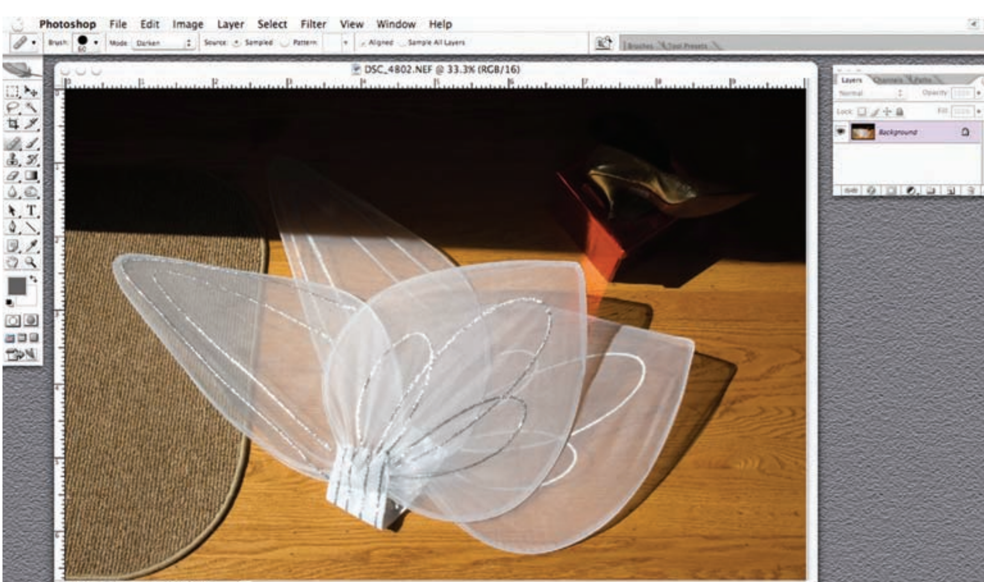


FIGURE 120 Highlight image.

Step 4

Holding down the shift key, drag the Highlight Image Layer from the Layers Palette onto the window of the Working image.

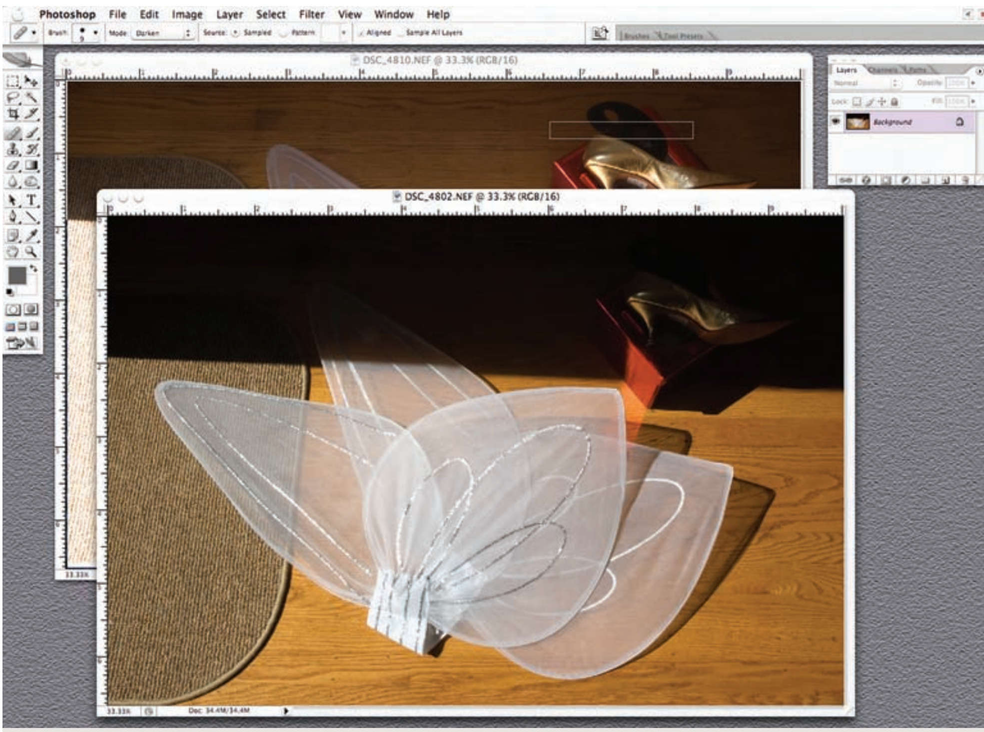


FIGURE 121 Dragging highlight layer onto working image.

Since these two images are exactly the same size, holding down the Shift key will place the Highlight Layer image precisely in the center of the Shadow layer image. Close the Highlight image file, you no longer need it.

Step 5

To check for precise registration between these two layers, with the Highlight Layer selected in the Layers Palette of the Working Image, use the Zoom Tool to magnify the image until you can see individual pixels. Next, use the opacity slider of the Highlight Layer to make the Highlight Layer semi-transparent. If you notice any problems with registration, select the Move Tool and nudge the Highlight Layer with the arrow keys until the registration is perfect.

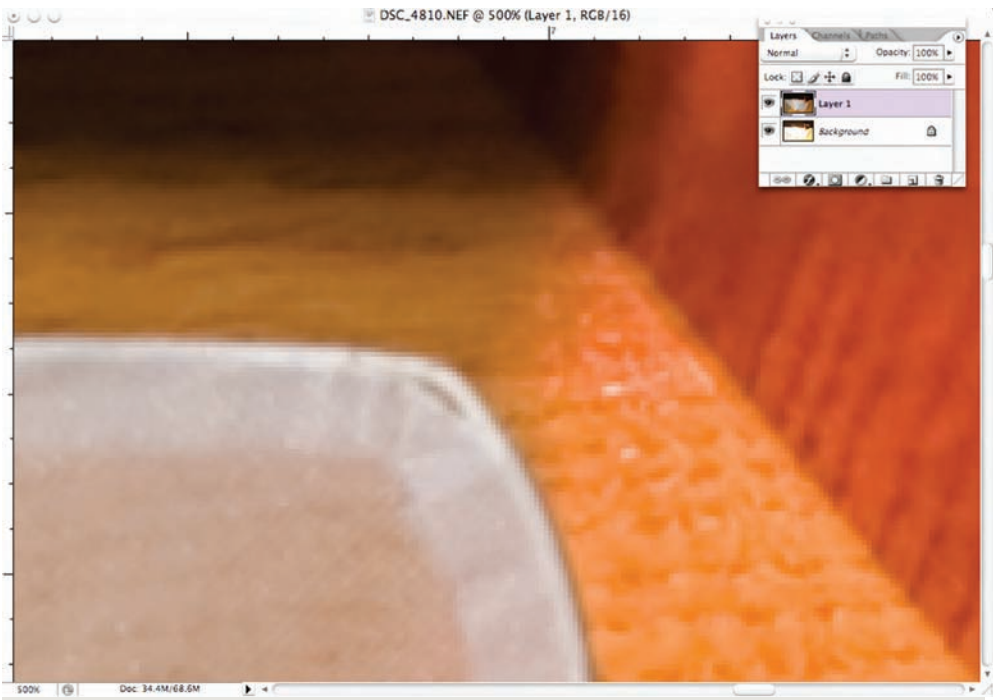


FIGURE 122 Checking the registration of layered working image.

Step 6

Return the Working Image to full size and make the Highlight Layer invisible by clicking the eyeball icon on the left side of the Layers Palette.

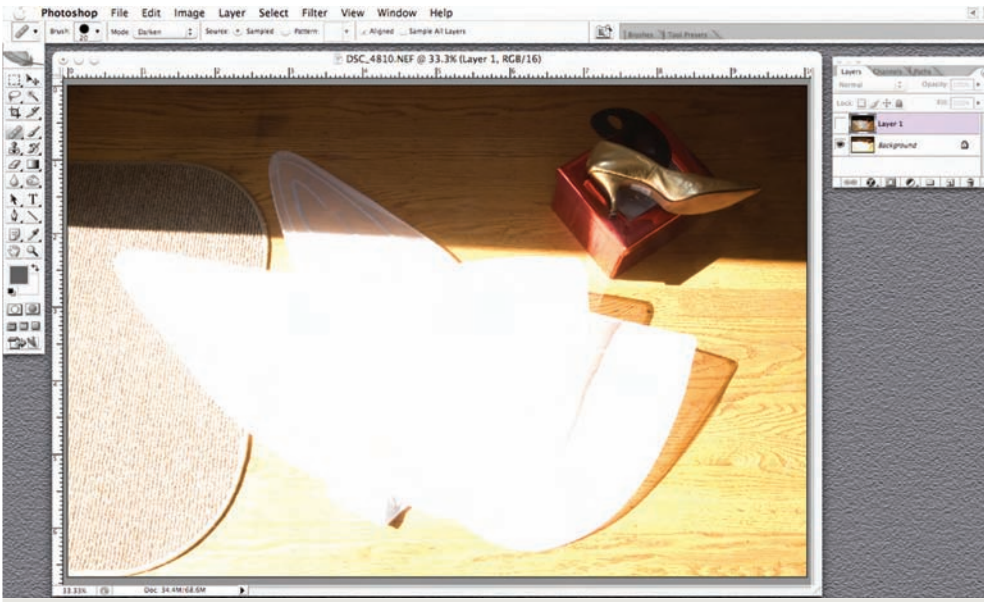


FIGURE 123 Working image with highlight layer invisible.

Step 7

Open the Channels Palette and, holding down the Command Key, click on the RGB Channel at the top of the stack.

What this step does is load a selection based on the highlights of the Shadow layer.

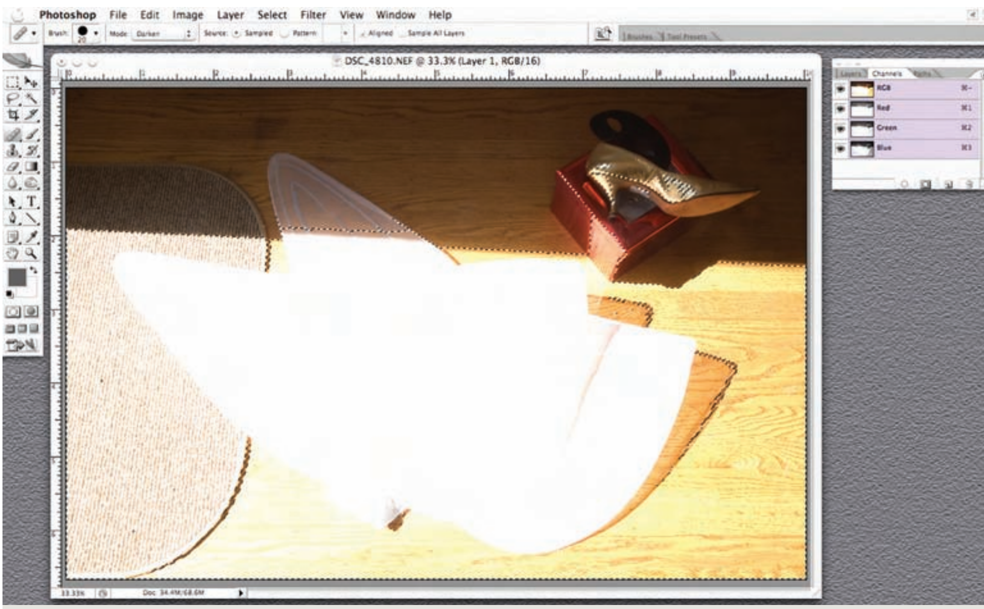


FIGURE 124 Working image with highlights selected in channels palette.

Step 8

Return to the Layers Palette and make the Highlight Layer visible.

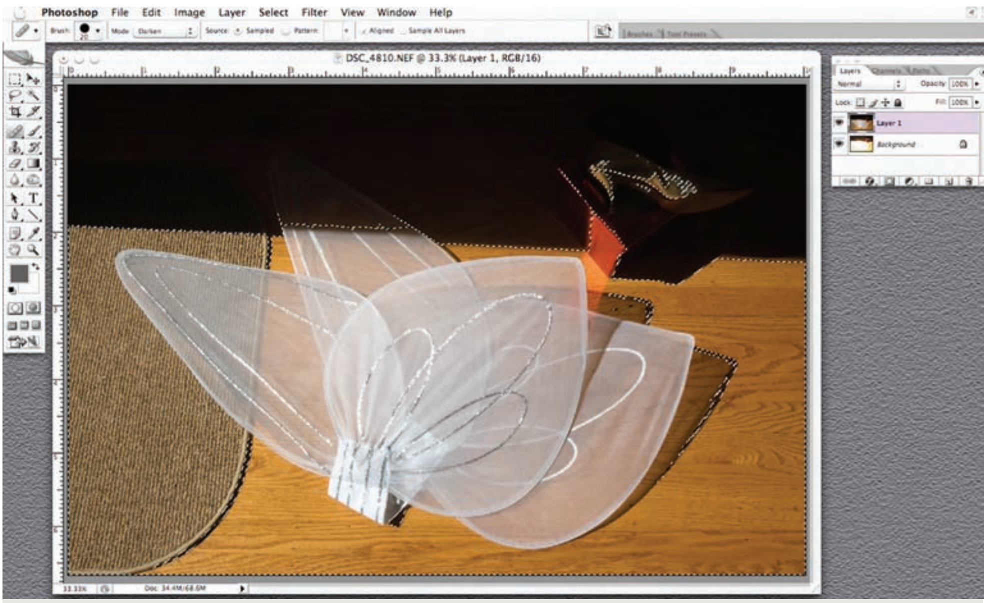


FIGURE 125 Working image with highlight layer visible and highlights selected.

Step 9

Click on the Add Layer Mask icon on the bottom of the Layers Palette and a layer mask will be created that combines the Highlights from the Highlight Layer, with the Shadows from the Shadow Layer.

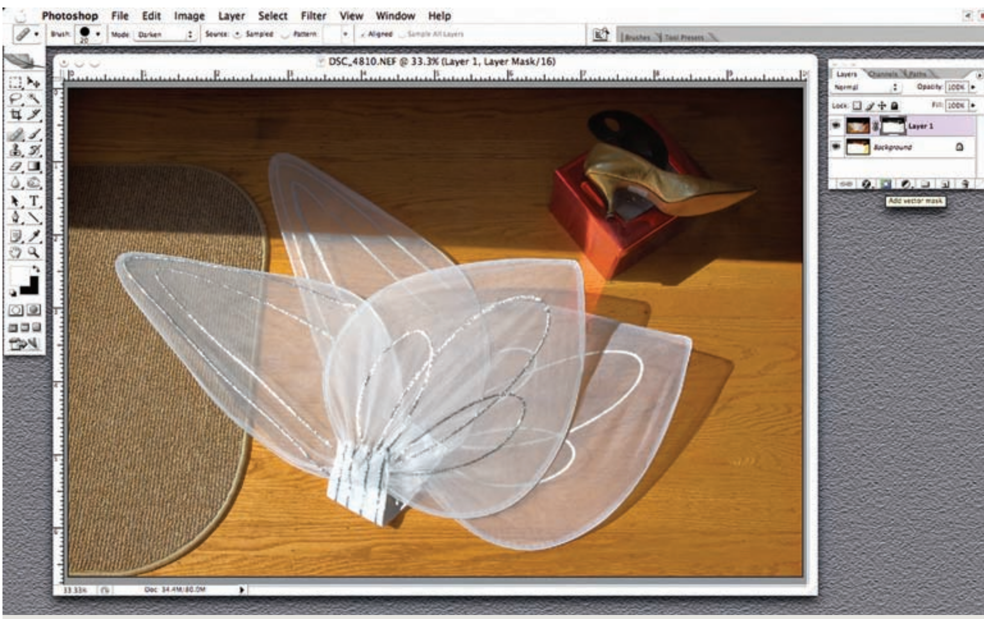


FIGURE 126 Working image with layer mask.

Step 10

Choose "Flatten Image" from the Layers Menu.

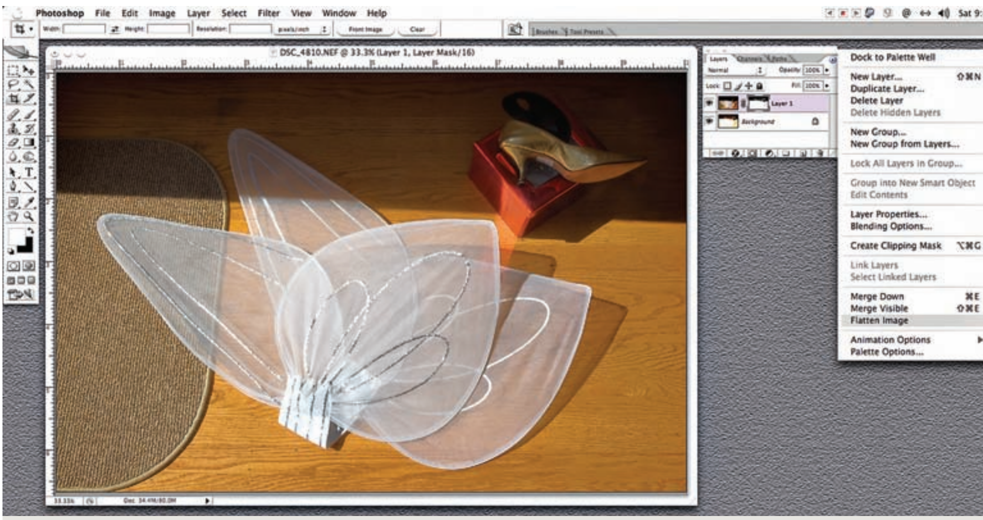


FIGURE 127 Flattened working image.

Step 11

With minor corrections in Photoshop, the result should be an image with perfect highlight, middle, and shadow values.

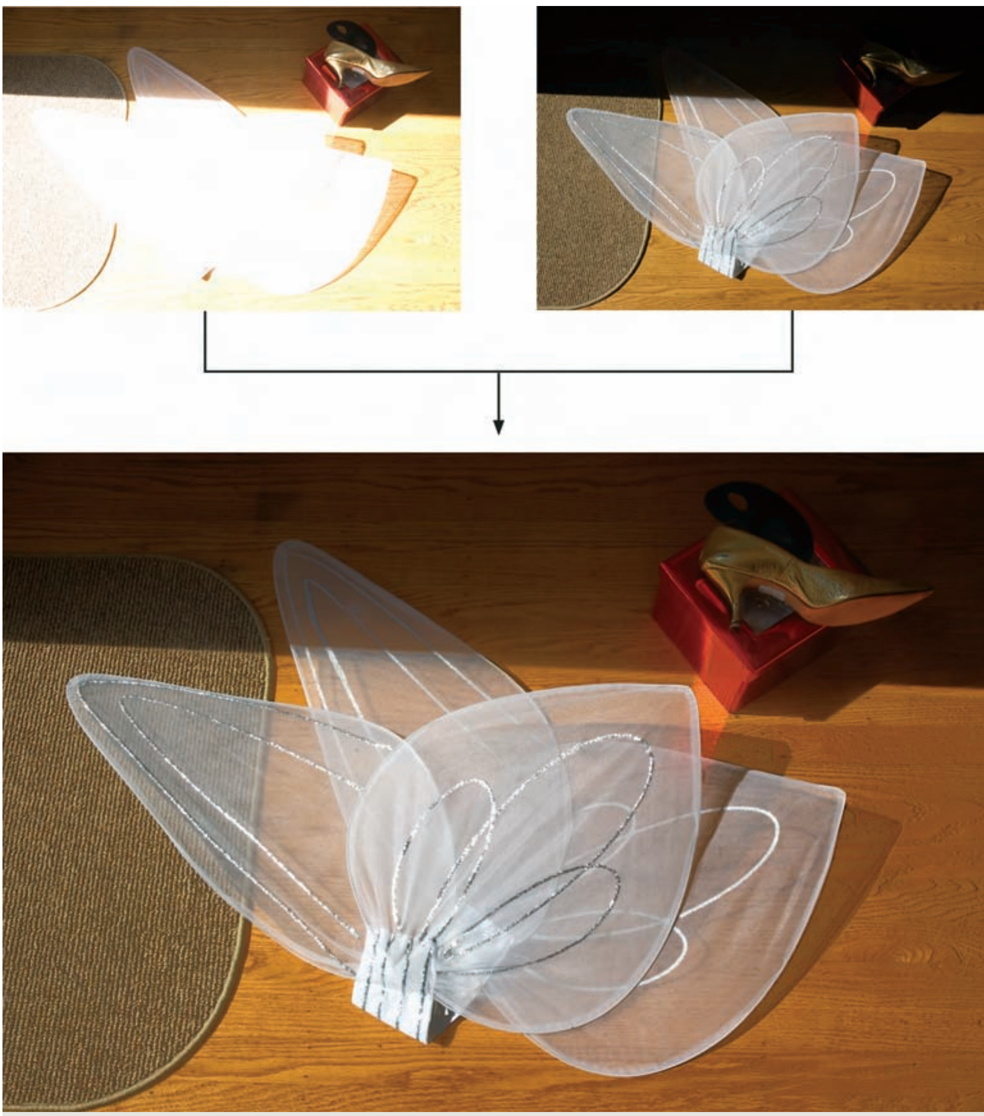


FIGURE 128 Finished blend of two layers.

Needless to say, there are numerous variations on techniques like this including an amazing new feature of Adobe Photoshop CS2 called Merge to HDR (High Dynamic Range) that will allow for the seamless combination of images to produce digital photographs with a range of contrast that would be unthinkable with film.
(See Appendix S for references to where detailed descriptions of these techniques can be found.)

But, as I mentioned, all of these techniques require that you use a tripod and photograph motionless subjects so, at the moment, there is still a place within the world of photography for the Zone System and the wonders of traditional film.

Summary of Digital Photography Cardinal Rules

This chapter contains many principles; suggested techniques and working methods that together will help you produce better photographs with your digital camera.

The reason I highlighted the following five Cardinal Rules is because they are easily overlooked and, if you did nothing else, these recommendations will greatly improve the quality of your work.

- **Always use the lowest ISO possible with digital cameras.**
  The ability to change ISO settings from one frame to the next is an important advantage of digital photography. Most photographers are familiar with photographic grain and some even use it to great aesthetic advantage. The same could be said of digital noise but if reducing it is your goal then this rule is the key.
- **Always shoot in Raw format unless you are certain that you will never need the visual information stored in the raw digital file.**
  Camera raw files not only contain much more visual information than JPEG images, allowing for larger, higher quality prints, they also contain useful metadata and make it possible for you to take advantage of raw conversion software.
  Unless image storage space is a priority and you are sure you will never need the advantages that raw files provide, this rule is always the best practice.
- **Scan or capture for your largest final print size and never interpolate if you can avoid it.**
  When scanning, always determine the largest image size you ever intend to make and use that as your output size. The resolution should always be at 300 dpi if your goal is to make a high quality ink jet print.
- **Expose for the highlights and process for the shadows. (Also known as: Expose to the Right.)**
  This is the general guideline for optimizing digital exposures. It helps you avoid banding by reducing the need for contrast adjustments and places your shadow values as far away as possible from the darker, pixel-level-deprived end of the histogram.
- **If you are shooting raw image files, do as much image correction as possible during the raw conversion stage of the process.**
  Because of the digital linear effect, raw images are fundamentally different from the same image after it has been converted into a tone-mapped file. Raw conversion software, and especially Adobe's Camera Raw application, takes advantage of this process allowing you to manipulate factors like image exposure and color temperature in ways that are impossible to reproduce with Photoshop.

Appendix A
Color Management, Profiles, and Color Spaces

I didn't really appreciate how efficient and inspiring digital photography could be until I produced the first print after color managing my system. Before that I was never sure that my monitor was a reliable tool for editing and previewing my work. After color management digital printing finally began to make sense and felt like a creative process.

Color Management is the general term used to describe the coordination of the key elements of digital image processing that allows for consistent color rendition from one step in the process to the other. Without proper color management you can't be sure that color is accurately displayed on your monitor or that the resulting prints you make will be the same as what you see on the screen. An ideal process would allow you to make one fine print after another without wasting time and materials on trial and error adjustments.

Although the technical details behind color management are complex (and beyond the intentions of this book), the process itself is fairly simple to implement if you understand some of the basic concepts involved and know how to apply them to the various tools you'll be working with in digital photography. If you are looking for a comprehensive book on this subject, consult Appendix S for some excellent references.

Profiles

Many of the best books on this subject refer to the now classic illustration of why color management is important and why color profiles are the key to making digital photography consistent and efficient. We've all had the experience of walking into an electronic appliance store and seeing an array of color TV sets for sale. They are all playing the same demonstration program and yet the colors from one screen to the next are often wildly different. Let's consider why this is true.

In general there are two things that make each TV set unique. First, there are settings that control the brightness, contrast, and saturation of each set and these are all different. But even if these settings were the same, the phosphors that produce the colors in the screens are all slightly different in the way they respond to the signal from the media source. If your goal was to create a way to ensure that all of the displays looked the same, you would need to follow these general steps. For each step I'll make reference to how this stage in the process corresponds to color management in digital photography.

1. First you would need to decide on what the "correct" rendition of the media source looked like.
   In the world of digital imaging this agreement on what the ideal rendition of all colors should be was done by the International Color Consortium (ICC) with representatives from all of the leading manufacturers of digital hardware and software. Together they created something called the Profile Connection Space (PCS) that is simply an unambiguous mathematical description of what "red" and every other color humans can see should look like.
2. The next thing you would have to do is accurately measure, or "Characterize" the color renditions of each TV set to see how it differed from the agreed upon PCS standards.
   Characterizing is the first step in the process known as "Calibration" in the digital world. In practical terms there are two ways that this is generally done. One is manually using either the Apple Display Calibration Assistant or Adobe Photoshop's Gamma software. I don't recommend that you use either of these because they rely on the human eye to make subtle comparisons, and this is a process that should be done with electronic consistency and precision. Instead I suggest that you invest in, or borrow, a relatively inexpensive monitor calibration device that will automate and vastly simplify this process. Appendix T contains references to where these can obtained.
3. Once you have measured the ways that each TV set differed from the universal standard you would need to make a series of subtle adjustments to bring them all into compliance with the agreed upon PCS standard. After this they would all look the same.

This step in the process is called "Profiling" because the monitor calibration device creates a small piece of software that tells the color management system how to compensate for the unique characteristics of your monitor. An ICC Profile can be illustrated in the following way.

One way to define "color balance" would be to say that the three primary components of color vision, Red (R), Green (G) and Blue (B), are all present in equal amounts in mixtures that when blended together would appear as "neutral" to your eye. These neutral colors are black, white, and middle gray. Computers translate visible colors into numbers and the values that correspond to the brightness of these colors are 0 for black, 255 for white, and 128 for a value half way between these extremes.

Neutral middle gray is measured as an equal amount of each of the primary colors and can be diagrammed like this:

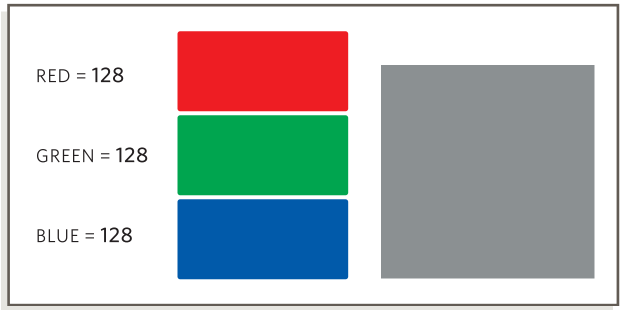


FIGURE 129 The digital color numbers of neutral gray.

If it happened that your monitor was lacking the colors red and blue in equal amounts and also some green, this would look to your eye like a darker than average gray with a "greenish cast."

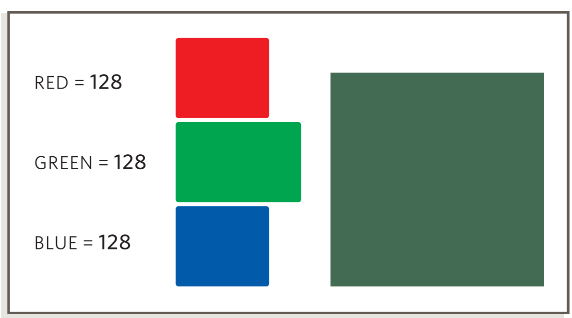


FIGURE 130 The digital color numbers of greenish cast.

To compensate for this imbalance you would first have to measure it with your calibration device and then create a profile that told you how to compensate for unique state of this monitor so you could bring it back into neutral balance.

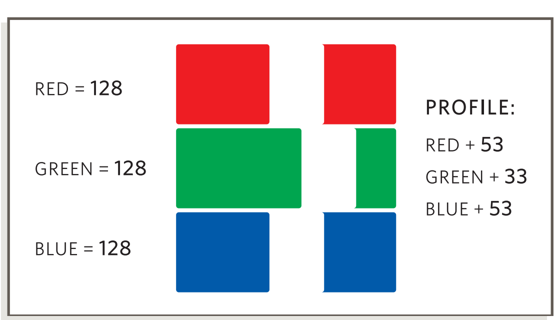


FIGURE 131 Building a color management profile.

In this case the profile for this monitor would say "Add Red + 53, Green + 33, and Blue + 53."

Once a unique and accurate profile was created and applied to each monitor in the store, they would all look the same.

This illustration greatly simplifies a much more complex process, but it makes the point that the function of a profile is to describe the unique state of an element in your system and provide the specific adjustments needed to make the appropriate corrections.

The profile doesn't actually make the correction itself, that is done by something called the Color Management Module (CMM). With Adobe Photoshop the CMM is called the Adobe Color Engine or ACE. In the case of this example, the CMM would be the person using the profile information to actually tweak each monitor.

With this example in mind you can see that **profiles need to be created and applied to every step and every element in the digital imaging process from capturing an image to printing it on a given brand of printer with a particular type of paper and ink set.**

These invisible little pieces of software are working in the background, together with the CMM to keep all of your image viewing, creating, and printing tools coordinated and consistent.

This process also allows you to attach profiles to your image files so that if you transfer your photograph to another color managed system, your images will look just the same as they do on yours. This is called "tagging" in the world of digital photography.

It is worth repeating that every make of printer, every brand of paper, and every set of inks has a unique profile. In some cases the profiles provided by the manufacturers of printers, papers, and inks will work perfectly with your system if you know how to apply them properly. In other cases you will have to create custom profiles that compensate for the idiosyncrasies of your system.

After spending days trying to create custom profiles for my system, I learned the wisdom of having it done for me by professionals who offer this as a very inexpensive service. See Appendix T for a list of references for this service.

I describe the steps of the process of applying profiles to your monitor and printer under the later section Color Managing Your System.

Color Spaces

Before we can move on to the practical steps for applying color management to your system, there is one other somewhat abstract concept we need to cover.

As I mentioned above, computers interpret visual colors as numbers that they can manipulate to produce the effects we see on monitors and digital prints. To define and visualize the range of colors that different monitors and printers can render, color scientists devised a system that models these different spectrums of colors as if they existed as three-dimensional rainbows called Color Spaces.

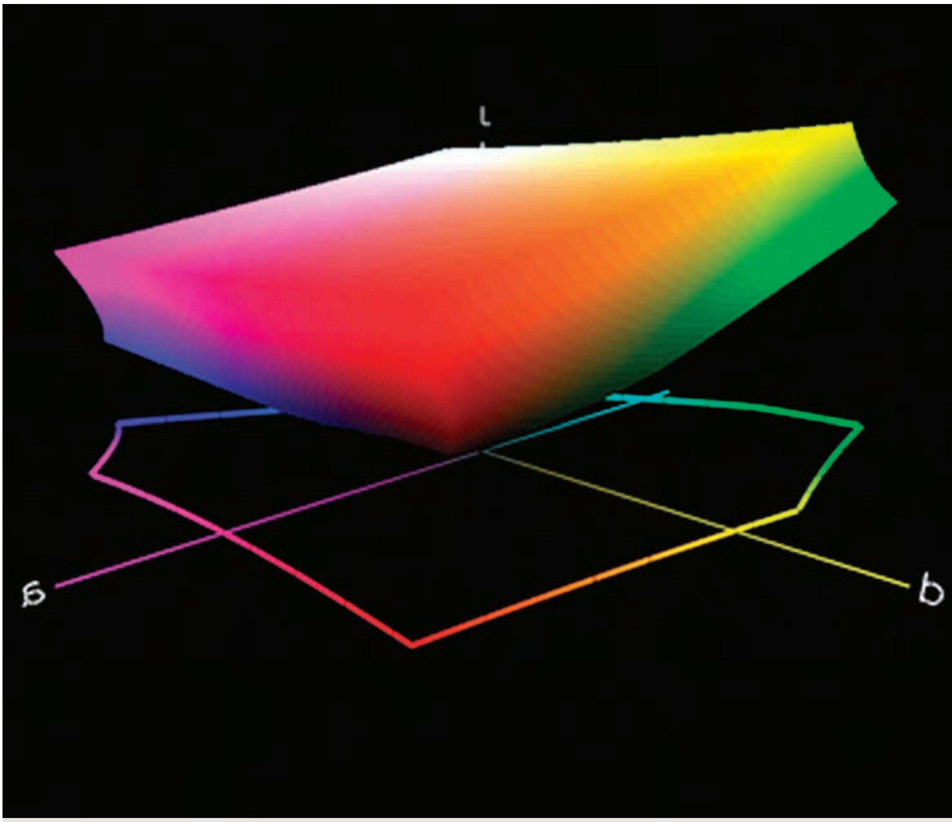


FIGURE 132 Adobe RGB 1998 color space.

Color spaces come in different sizes that depend on what they are designed to represent. For example, the Lab color space is extremely large because it represents all of the colors possible for the human eye to see. The sRGB is relatively small because it represents only the colors that can be rendered in a typical web browser. There are even color spaces that represent the colors that can be printed on a given paper with a given set of inks.

Understanding color spaces is useful because one key decision digital photographers have to make is the color space they will use as the "Working Space" for their computer systems. You can think of this as the arena or "gamut" within which all of your digital image editing takes place. Any colors that fit inside a given color space are said to be within that space's gamut; any colors that don't are said to be "out of gamut."

Problems can arise when there is a mismatch between the color space you have chosen to work in and the color space of the image you are working on. If your working space is too small for the image you're editing, colors that were present in the image will simply be compressed until they fit within the gamut of your working color space. You'll notice this as a loss of subtlety and saturation in your image.

On the other hand, if your working color space is much bigger than the images you're working on, the image's colors will be spread out when you try to edit the image creating gaps called color-banding and posterization.

For this reason it makes sense to choose a color space large enough to encompass the colors of your work, but not so large that it creates its own problems.

One nice feature of color spaces is that they can be modeled in three dimensions with software like Color Think from Chromix and even be combined to see how they compare with each other.

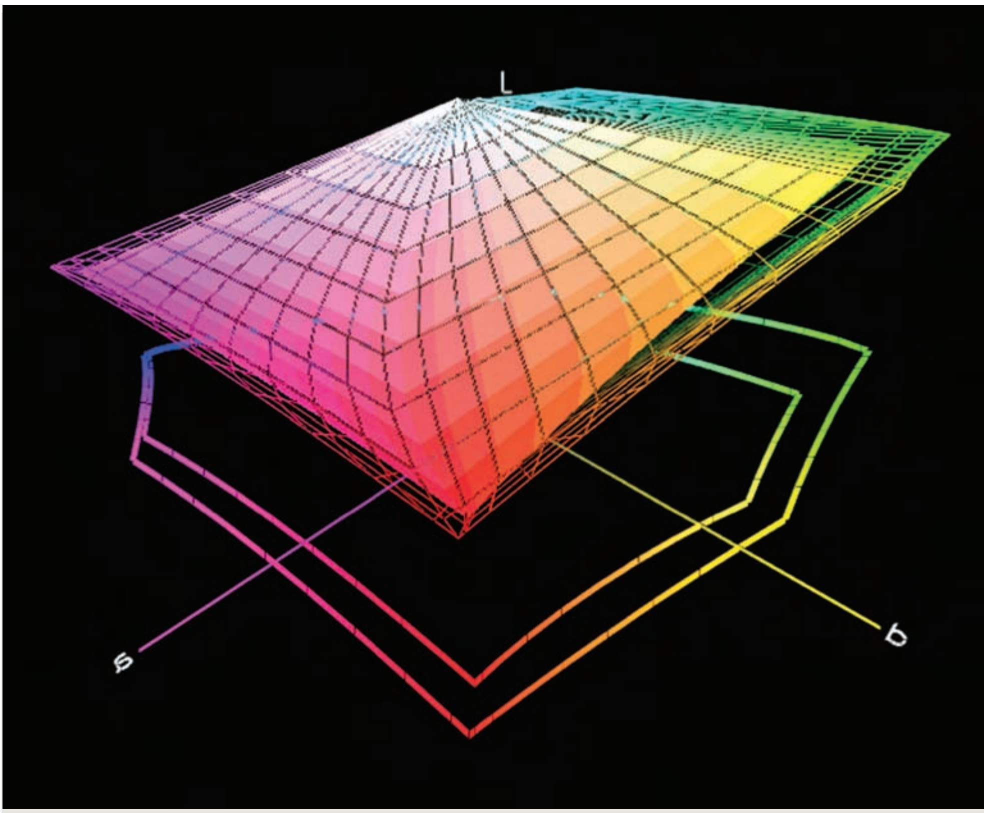


FIGURE 133 Adobe RGB 1998 and sRGB color spaces compared.

In Figure 133 the sRGB color space is shown embedded in the Adobe RGB 1998 color space and, as you can see, the Adobe color space (shown as a wire frame) is much larger because, in general, it is designed to account for the colors of images intended for ink jet printers.

Current, high-quality ink jet printers are designed to print colors that are even beyond the range of Adobe's RGB 1998 color space. Figure 134 is a comparison of Adobe's color space and a custom profile I had made for my Epson printer.

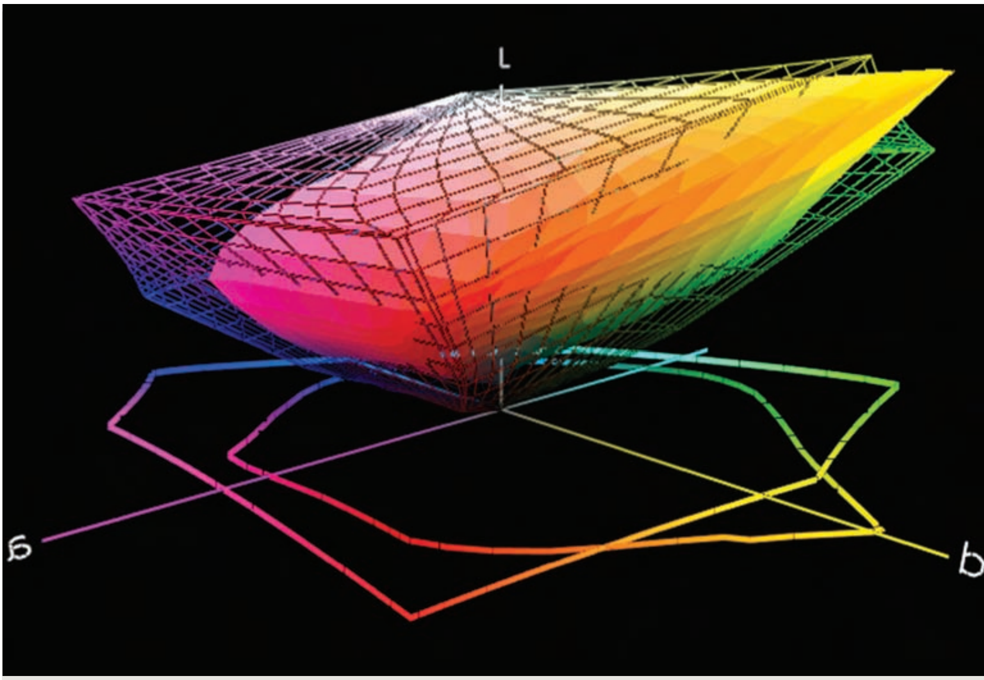


FIGURE 134 Adobe RGB 1998 color space (wire frame) and a custom profile for Epson Pro4000 Premium Luster paper and ink set.

Notice that although the Adobe color space is generally very large, there are intense yellow colors that are beyond its gamut. If you were to bring an image that had these colors into an Adobe RGB 1998 working space they would be "clipped" or converted to less saturated numbers.

Digital editing software can be set up to warn you when colors are unprintable or out of gamut.

An alternative would be to use a larger color space like ProPhoto as your standard working Color Space and then use the Epson profile when you print. The later sections Choosing your Color Space and Choosing your Printer Profile explains how to do this.

Once you define a given color space as your working standard, that information is tagged on to every image you edit and save. If you send that file to someone whose computer is set to a different working color space, Photoshop will alert you there is a color space mismatch and offer you choices for conversion.

Color spaces are known by initials like "CIE LAB" or "LUV," but for digital photographers the following is what you need to know about the most widely used color spaces:

- **sRGB** is a relatively small color space designed to provide a convenient standard for consumer digital cameras and Web designers. In general, sRGB is too small a color space for digital photography intended for fine ink jet prints.

- **ColorMatch RGB** is a standardized monitor color space that is often used as a default when more specific color spaces aren't available. It has a wider gamut than sRGB but a smaller one than Adobe RGB 1998.
- **ProPhoto RGB** is an extremely wide color space preferred by many digital photographers who work with high-quality images intended for reproduction on photo-quality ink jet printers or recording on photographic film.
- **Adobe RGB 1998** is a wide gamut color space that is currently preferred by most digital photographers making fine ink jet prints.

Color Managing Your System

Applying color management to your system only requires understanding three basic concepts.

First, you need to choose the appropriate color space for the kind of images you plan to create.

For the majority of digital photographers this is a very simple decision:

- If you are primarily planning to display your images on the Web, choose sRGB as your working color space.
- If you plan to make fine ink jet prints from your digital files choose either Adobe 1998 or ProPhoto RGB.

In practice the difference tends to be that only experts use ProPhoto RGB because its extremely wide gamut requires some skills to manage. Adobe RGB 1998 is generally the safer choice for most photographers.

Secondly, as stated above, in theory all elements of a complete digital imaging system need accurate color profiles and these need to be applied consistently.

This could mean calibrating and creating profiles for everything from your camera, scanner, monitor, printer, and every paper you work with. But in the real world only a well-calibrated monitor and printer/paper profiles are essential.

Finally, there are three different color managers and each controls a different part of the overall process. It's important that you understand how to coordinate these three pieces of software so you can avoid conflicts that cause the most common problems.

- Apple's color management software is called **ColorSync** and in general it works in the background to make sure that the various color profiles are properly applied.
- Adobe Photoshop uses software called the **Adobe Color Engine** (ACE) that manages the color profiles for your monitor, images, and printers.
- Your printers and scanners use software called "**Drivers,**" which handles color profiles for each of these devices.

The Step 4 below titled: Resolving Color Management Conflicts explains how to coordinate the functions of these different software tools.

Step 1 – Calibrate your monitor

A precisely calibrated and profiled monitor is absolutely essential for any of the other steps in color management to work properly. There's an understandable tendency to take this step for granted because the images on the screen may look "good," but remember that the key to color management is creating a coordinated system where all of the colors you work with match universal PCS standards. These standards are numerical so your monitor readouts need to be measured precisely and the resulting profile needs to be stored as the standard for your system.

My strong recommendation is that you use one of the many monitor calibration devices that are available for this task (see Appendix T). The process takes about 10 minutes and requires you to make a few important decisions:

- **White Balance.** This determines the color of white that your eye uses as a point of reference for judging all other colors. I use 6500 k (Medium White) as my standard but this is purely a personal choice.
- **Gamma.** This sets the contrast ratio that your system uses as a standard. For Macintosh computers the default is 1.8 and for PCs it's 2.2.
- **Luminance.** Most calibration devices give you the option of setting the brightness of your monitor to a recommended standard. For LCD monitors this is 140 lamberts.

How often you should calibrate depends on the type of monitor you are using. CRT displays generally require more frequent calibration than LCD monitors, but it's a good idea to do it weekly just to be sure that it's correct when you need it.

Step 2 – Choosing your color space

The next important step is selecting a color space for your system that sets the parameters within which all of your color management operates. This is done in the Color Settings dialog box in Adobe Photoshop.

The most important choice for this step is found in the "Working Spaces" box. As described above, if you are planning to create images primarily for the Web you should choose sRGB as your color space. If you plan to print your images on an ink jet printer you should choose Adobe RGB 1998 or ProPhoto.

All of the other Adobe default settings work well for most purposes.

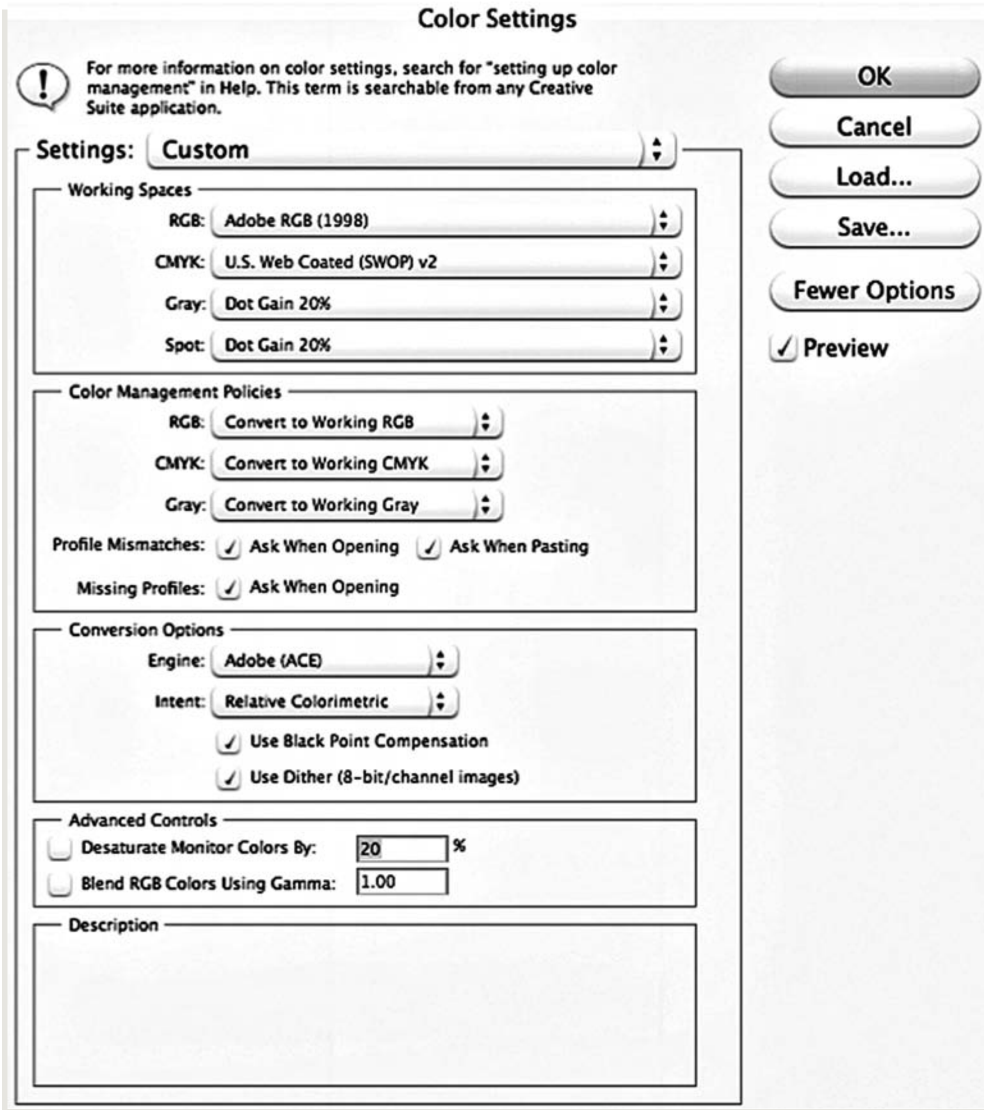


FIGURE 135 Adobe Photoshop Color Settings Box.

Step 3 – Choosing your printer profile

There is probably more confusion about these final two steps than anything else in color management, yet the two issues involved are really very simple:

1. Your computer needs to know what profile to use for the particular printer and paper/ink combination you are using.
2. You have to resolve potential conflicts between Photoshop and your print driver that both have color management capabilities.

Step 3 asks you to select the profile that will give you the most consistent color match for the specific printer and paper/ink combination with which you are working. To do this you first have to make that profile available to your system and then enter it in the right place when you make a print.

Remember that a profile compensates for the idiosyncrasies that make every monitor, printer, or paper unique. Different paper surfaces absorb ink colors in slightly different ways so that a print that looks perfect on one paper could look green or magenta on another. To create an accurate printer/paper/ink profile you first have to make a test print that includes a complete spectrum of colors and then compare those renderings to known PCS standards. The resulting profile adjusts the printer settings so that the colors match the colors on your calibrated monitor as accurately as possible.

Every manufacturer of ink jet printers distributes a set of profiles that is designed to work with the inks and papers they recommend. These are usually installed when you install the print driver for your printer and in most cases they will work very well if you know how to apply them. But of course if you decide to use a paper or ink set that is different from what the canned profile was designed for, your prints may no longer match your monitor. At this point you will either have to create a new profile on your own for this new printer/paper/ink combination, or have it done for you by a professional. As I mentioned, after days of attempting to do this myself, I learned that the latter choice is far more practical. (See Appendix T for references to reliable and cost-effective custom profilers.)

A typical printer profile will have a name like "Pro4000 Enhanced Matte." As you can see, this profile is specifically designed for the Epson Stylus Pro 4000 Printer using Epson Enhanced Matte paper and inks. If this is the combination you're using, your calibrated monitor and the resulting print will match. Any other profile may give you different results.

Some printer manufacturers install their profiles in folders that aren't easily accessible, but any custom profiles you make should be stored in the following folder on current Macintosh computers:

Home folder > Library > ColorSync > Profiles

Assuming that it's installed properly, the following steps will allow you to apply this profile:

1. In Photoshop, when you are ready to print an image, select "Print with Preview" from the File menu.
   You will now see a large dialog box like Figure 136.
   Notice that under the preview window there's a drop down menu with two choices: Output and Color Management.

FIGURE 136 Adobe Photoshop Print with Preview dialog box.

2 Choose Color Management.
3. In the Options box under Color Handling, choose "Let Photoshop Determine Colors" from the drop down menu.
4. Under Printer Profile, choose the correct profile for the printer and paper/ink combination you are planning to use.

At this point it's important that you tell your computer which print driver it should use and what paper size and print orientation you want. You do this through the Page Setup button on the right of the Print with Preview box.

Make sure that you select the correct print driver from the "Format for:" drop down menu and that your paper size and orientation are correct. Click "OK" and you're now ready to move on to the final step.

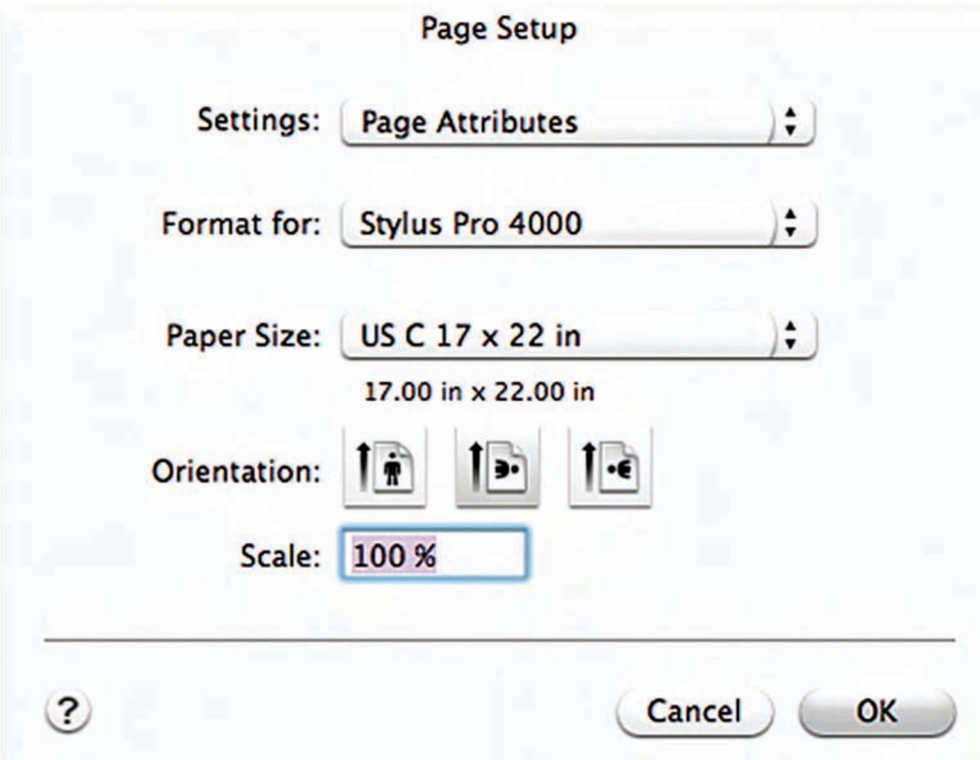


FIGURE 137 Apple Macintosh Page Setup dialog box.

Step 4 – Resolving Color Management Conflicts

When you click the Print Button in the Print with Preview window you will move to the Print Driver box where you have to make a few extremely important choices.

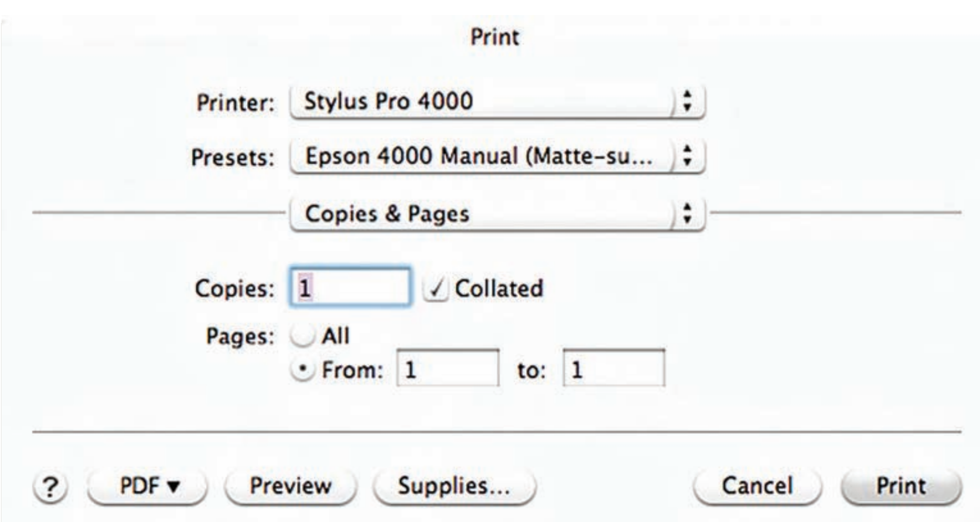


FIGURE 138 Apple Macintosh Print Driver box #1.

The Print Driver box controls all of the specific behaviors of the printer, including the way the printer applies color management if you allow it to.

Printer color management software works well if the application you're printing from doesn't have color management capabilities, but my experience has been that Adobe Photoshop's software does a much better job.

The crucial thing to remember is that, **if both Photoshop and the Print Driver try to color manage your image the conflict will result in a terrible print. This is the most common mistake that beginning digital photographers make.**

For Epson printers you resolve this conflict by going to the drop down menu that by default is at first labeled "Copies & Pages." Scroll down to the Printer Color Management box and set the print driver to "Off" (No Color Adjustment).

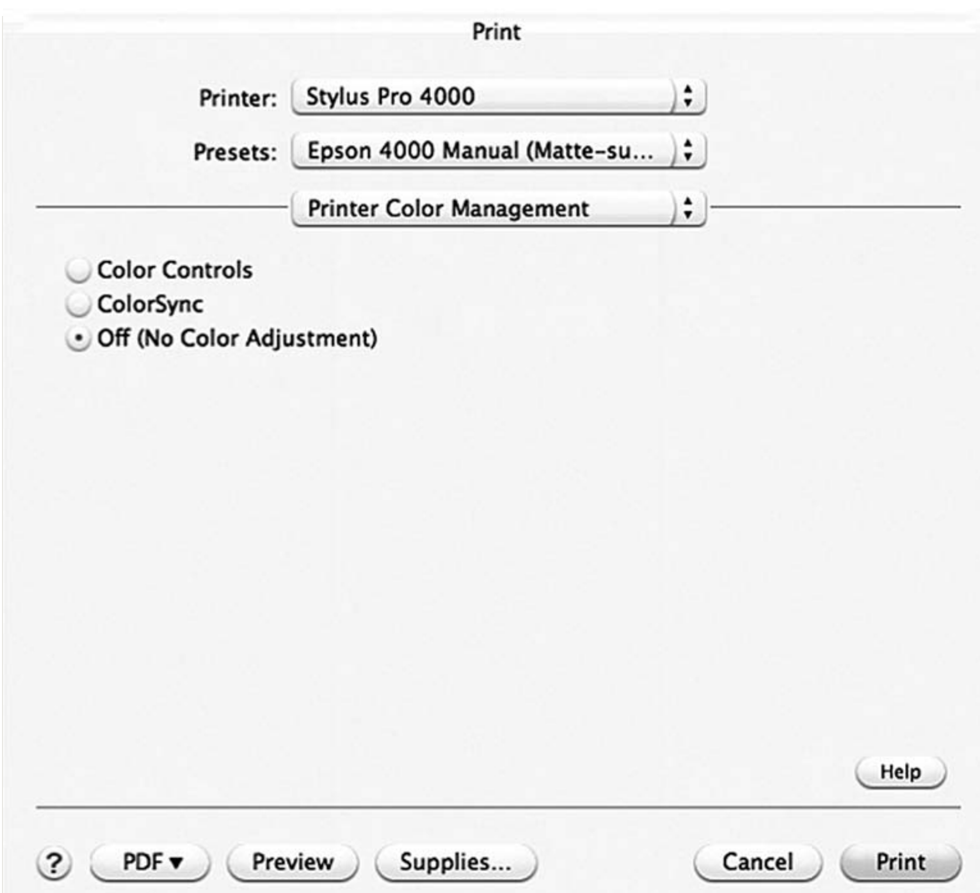


FIGURE 139 Apple Macintosh Print Driver box set to Turn Off Epson Color Management.

Next, from the same drop down menu scroll up to the Print Settings box.

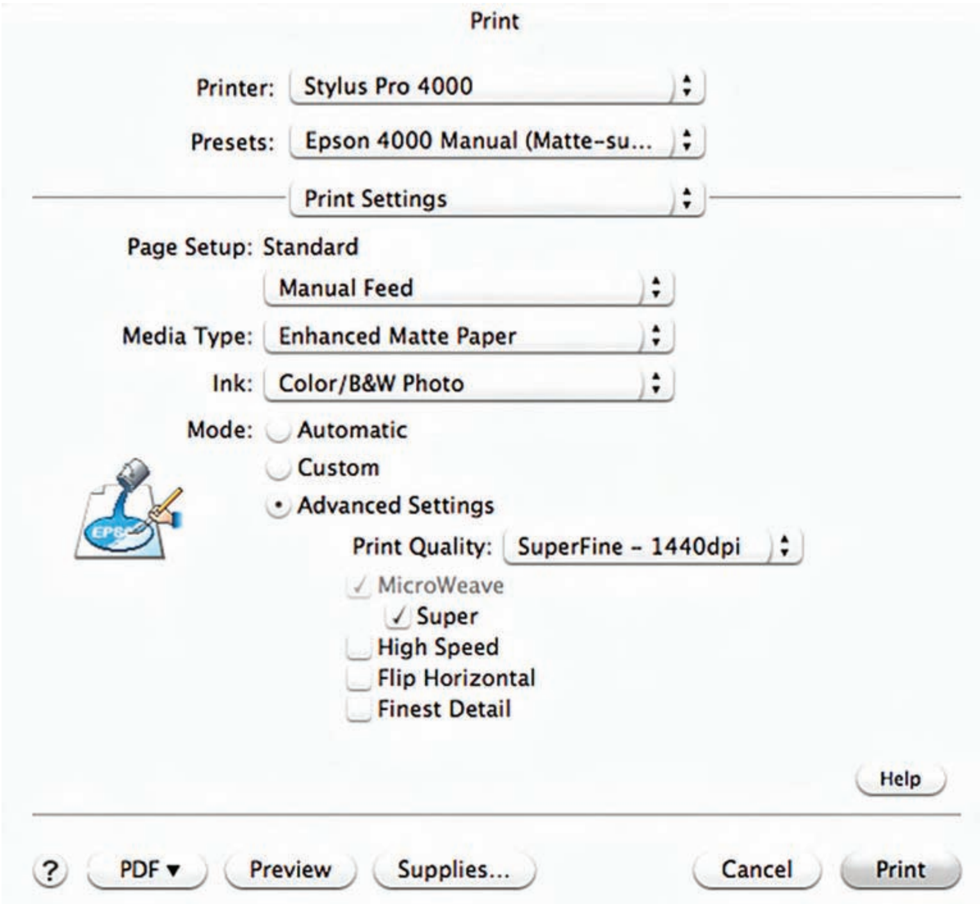


FIGURE 140 Apple Macintosh Print Driver Box set to Printer Settings.

Make sure that the settings are as follows:

Printer: The printer you plan to use.

Presets: It's a very smart idea to save presets that contain all of the specific settings you customarily work with. This will save you lots of time in the future.

Media Type: This should be set to the specific paper you are planning to print on.

Mode: These settings define the quality of the print you intend to make. Advanced Settings > Print Quality: Super Fine 1440dpi > High Speed (Off) will give you to best print.

At this point it's a good idea to get into the habit of scrolling down to Summary to double check that the Print Driver is set the way you want it to be. **Most especially make sure that the Color setting is still set to "Off."**

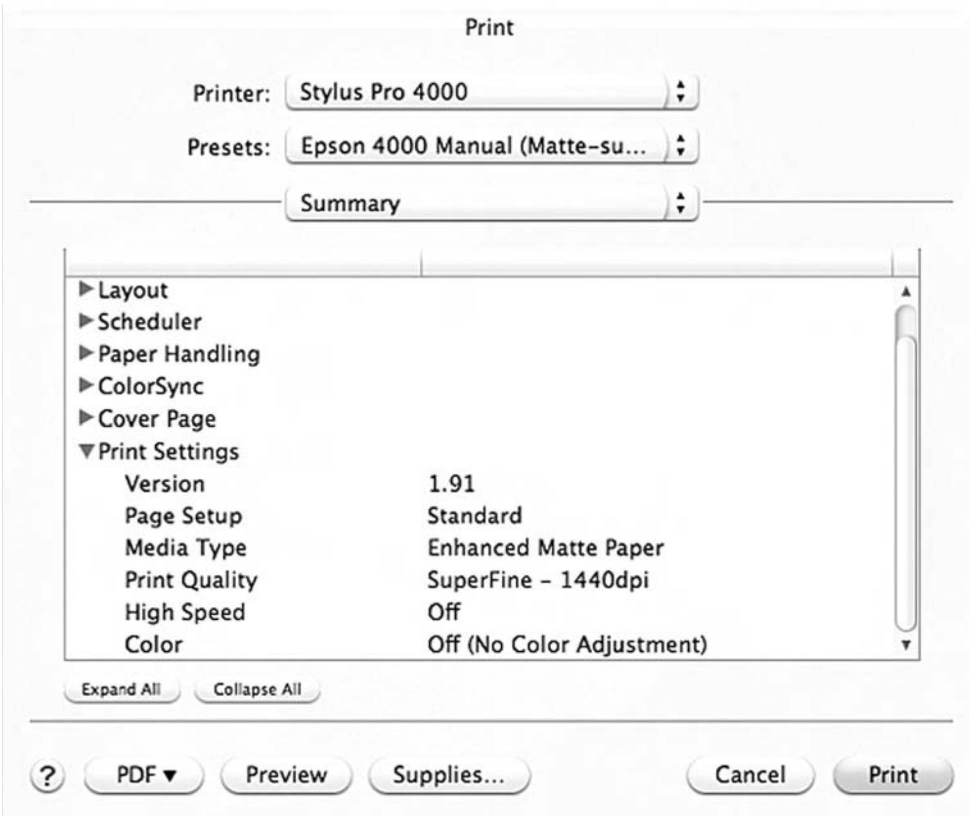


FIGURE 141 Apple Macintosh Print Driver Box set to Summary.

When you click the Print button your printer should now produce a print that very closely matches the image on your monitor.

That's what effective color management is all about.

The RIP Solution

The procedures and principles I've described in the preceding sections are vital for all digital photographers to know and understand but I must admit that, in real life, I base my digital printing workflow on an expensive but extremely effective alternative called a Raster Image Processor (RIP). There are a number of these on the market but I use the ImagePrint RIP produced by Colorbyte. A RIP completely replaces the color management systems built into the Photoshop Print w/Preview box and the ink jet printer driver with its own sophisticated software, which applies high-quality profiles, flexible page layout tools, and remarkably effective ink-handling solutions. One of the problems continuing to plague even the best color-managed systems is the fact that ink jet printers have a difficult time rendering grayscale images with perfectly neutral black and gray tonal values. There currently are also frustrating limitations on the size of the print you can make on roll paper when using the built-in print drivers that are available. RIPs completely resolve all of these problems and even offer specialized profiles designed to neutralize color shifts that appear when your print is viewed under florescent and tungsten light sources. As I mentioned, RIPs are expensive, but I've found that they are well worth the investment if your goal is to produce the highest quality digital images.

Appendix B
What is a Pixel?

Pixel Size

The easiest way to confuse a beginning digital photographer would be to ask him or her, with a straight face: What size is a pixel?

The reason this is a trick question is because the size of a "pixel" entirely depends on the kind of pixel it happens to be. This is why the definitions of pixels and resolution can be so confusing.

The word "resolution" refers to the number of pixels there are per inch of a given imaging media.

In terms of size, pixels come in two different types: Fixed Hardware pixels and Variable Image pixels.

Screen Pixels

On the surface of a computer monitor, a pixel is a fixed and rigid physical entity that can never change size. The resolution of monitors is set to values like 72 or 96 pixels per inch and that always remains the same.

But keep in mind that these "monitor pixels" are only the tiny dots that create the "image pixels" you see on the screen.

When the screen is displaying a digital image, these "screen pixels" are used to create image pixels that can be almost any size. For example, when one of these screen pixels is used to reproduce one image pixel, the image display in Photoshop reads 100% or "Actual size." When two screen pixels are used to display one image pixel the image shrinks to 50%.

Digital Image Sensor Pixels

The size of pixels on the surface of a digital image sensor inside of a camera is also rigidly fixed.

In a 6 megapixel camera chip there are just over 6 million pixels on the chips surface and they can't change size.

Digital chip pixels are organized like this:

FIGURE 142 Digital camera sensor.

These fixed sensor pixels store the visual information that computers use to create digital images.

The amount of information recorded by a 6 megapixel sensor is enough to create an approximately 9″ × 12″ image that prints with 240 dots per inch on an ink jet printer. In terms of digital image quality, this resolution number is the one that means the most.

Scanners

Scanner manufacturers represent the fixed, optical resolution of their products with two numbers: 1200 × 2400 dpi for example.

In this case 1200 would be the number of sensors that are positioned horizontally in the scanner head and 2400 would be the number of steps the carriage motor can take as it travels one inch down the film or document being scanned.

When they claim that their scanner has a maximum resolution of 9600 dpi they are describing the amount of information the scanner software can interpolate, or fake.

Digital image pixels that are created by scanners can be many different sizes depending on how many slices, or "samples," the scanner divides the image into. For example, a 300 sample per inch (spi) pixel is 1/300th of an inch wide. A 1 spi pixel is one full inch wide!

Scanners usually refer to the image pixels they create as dots per inch or dpi because, just like camera sensors, the scanner is recording visual information that is intended to be rendered as dots of pigment on the surface of photographs created by an ink jet printer.

One other measure of a scanner's quality is its density range. This describes the amount of contrast the scanner can record and the higher this number the greater the scanner's ability to render detail in the shadow areas. Density range numbers above 3.2 are very good.

Printers

The dots per inch that we see as image pixels in ink jet prints are actually made from extremely small clouds of pigment deposited on the paper by the physical holes in the print head of the printer.

For example, there may be 1440 of these tiny holes in the printer head that spread ink on paper to create the image pixels we see in the print.

Appendix C
Bit Depth

Computers store information electronically in the form of a number that at the simplest level can either be 0 or 1. This is called one "bit."

An 8 bit number in a computer has 8 digits and is called a "byte." So, an example of a bit would be 0 and a byte would be 0000 0000..

Here is how bit depth is notated in digital photography:

8 bit images have a bit depth of 256 levels because if you multiply the number 2 by itself 8 times the result is 256 (2 — 4 — 8 — 16 — 32–64 — 128 — 256).

By this same logic, 12 bit images have a bit depth of 4096 levels per pixel and 16 bit images have a bit depth of 65536 levels per pixel.*

Also, in Adobe Photoshop, for technical reasons, 16 bit images only have 32,769 pixel levels instead of the 65,536 you would expect.

The visual information in digital images is organized into channels that hold all of the data of either black-and-white tones or gray or each of the three primary colors of red, green, or blue (RGB).

It's interesting to consider how many actual colors this translates into. As noted above, an 8 bit black-and-white image has only one channel that's called "Gray," so there are only 256 tones available.

An RGB color image has three channels with 256 pixel levels each, so this adds up to 16,777,216 color possibilities ($256 \times 256 \times 256$).

You would think that over 16 million colors would be more than enough when you consider that the human eye can only perceive about 17 million different colors.

But, as you have seen in Chapter 10, pixels colors get lost in the process of editing and the translation from one color space to another. So, to provide leeway to cover this potential loss, scanners can provide 16 bits per channel which adds up to 281,474,976,710,656 color numbers!

One important consideration related to bit depth is that jpeg images are only 8 bit, but if you shoot your images in your camera's raw format, the images will have 12 bits per channel.

*Two issues of terminology that can be confusing are that JPEG colors images that actually only have 8 bits per channel are sometimes referred to as 24 bit images because the three separate 8 channels add up to 24. These are still only 8 bit images because each channel only has 256 pixels levels each.

Since 12 bit image files have 16 times more pixel tonal levels than 8 bit JPEG files, when digital photographers choose JPEG format for their work they are essentially wasting thousands of tonal levels that would otherwise be available to work with.

For this reason, unless you are sure that you'll never need to make large or high-quality prints of your image, you should observe the following rule:

Always set your camera to Raw, (the high bit format) when you shoot.

Note: Not all digital cameras offer the option to shoot in raw format. This is a good reason to carefully check the camera's specifications before making a purchase.

One of the practical reasons not to shoot raw would be that JPEG images use less memory on your storage media so you can capture more images per disk or card.

Also, raw images have to be converted to one of the viewable and editable formats like .tiff, or .psd before you can work with them in Photoshop, and this takes some time and knowledge. Still, the gain in quality is usually well worth the effort of buying a larger storage card and learning how to use the conversion software.

Appendix D
Exposure and the Digital Linear Effect

Linear vs. Non-Linear

Although the light meters built into digital and film cameras are essentially the same, the way these two processes record and respond to light is different in ways that are important to understand. One simple way to begin looking at this is to consider the graphic systems we use to record the relationship between exposures and print tonalities.

In 1890 the photographic researchers Ferdinand Hurter and Vero Driffield published a seminal paper demonstrating what happened when you plotted exposure and film density on a graph with logarithmic intervals.

If the relationship between light exposure and film density were consistently simple and proportional (or "linear") the resulting line on the graph would be straight indicating that, from the darkest value to the brightest, doubling the exposure by stops would produce twice the film and print density.

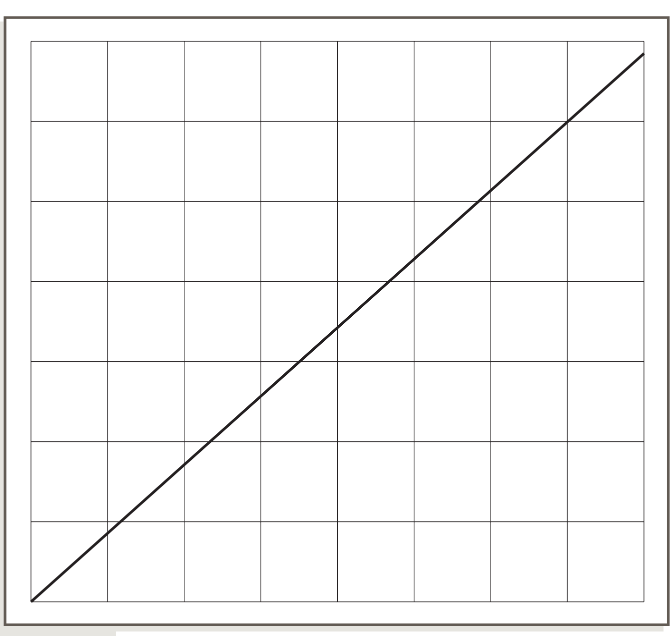


FIGURE 143 A linear ratio of exposure to negative density.

Instead, what they discovered was that the result was a line with a characteristic curve that was similar for all films and developers.

This curve indicates that equal amounts of exposure don't produce equal amounts of film density throughout the full range of tonal values. At the darkest and brightest ends of the scale the responses of film to light are compressed or "non-linear."

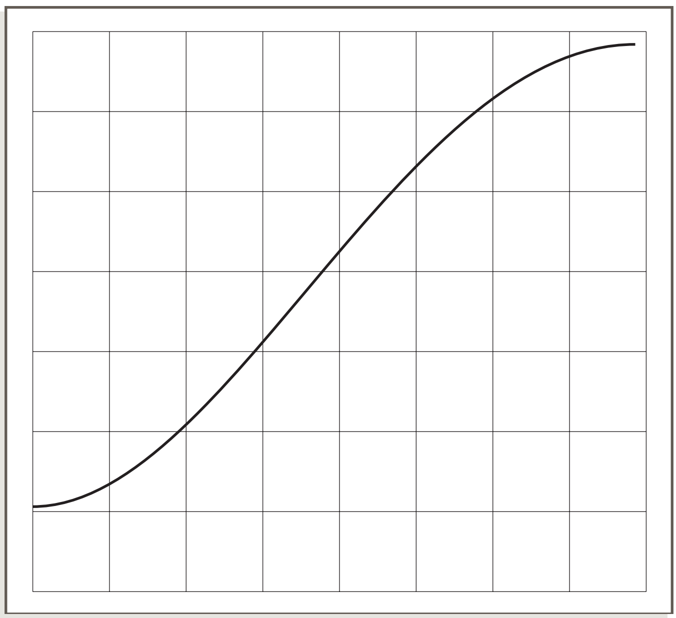


FIGURE 144 The characteristic curve of exposure to negative density.

Non-Linearity, Zones, and Human Vision

Let's consider how this corresponds to the familiar Zone Scale and, more important, to the ways that we perceive light.

What the characteristic curve shows is that there is less contrast in the darkest and lightest values than there is in the middle tones.

This corresponds to the fact that when the light in a room is very dim it is hard for us to see the difference between various objects on the walls and floors. This is also true if the light is blindingly bright. It is only when a moderate or normal amount of light is available that we can see clear distinctions between different surfaces.

If you look closely at the Zone Scale you can see this same relationship between the various Zones. There is more difference between Zones V and VI than there is between Zones I and II.

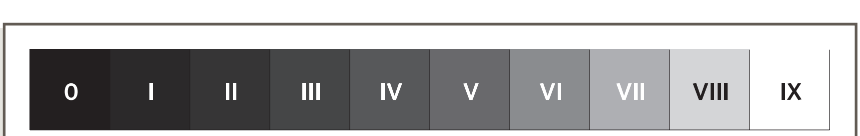


FIGURE 145 The Zone Scale — A non-linear representation.

The fact that human vision responds to light in a non-linear way means that we are able to see over a much greater range of brightness levels than would otherwise be true. Some of this non-linear response is due to the fact that our pupils open wider when it's dark and close down when it's very bright.

But in a deeper sense, the biochemistry of the light-sensitive cells in our retinas also contributes to this effect in ways that are very similar to the effects of light on film. This is known as the Adaptation Effect of human vision.

In the Zone Scale representation of non-linear gradations, there is a natural amount of compression of the tonal values at the high and low ends of the scale, which allows for a very even distribution of the tones on the scale.

This is why the middle gray tonal value (Zone V) falls in the middle of the Zone Scale in a way that feels "natural" to our eyes.

The Digital Linear Effect

The reason why all of this is important is because digital camera chips respond to light in a very simple and straightforward way that has important implications for digital photographers.

We can say that the response of digital chips to light is "linear" and the following example illustrates what this means:

Imagine that Figure 146 is a digital light sensor that responds to light by filling up with photons until it reaches its capacity. As of this writing, digital sensors are able to record approximately

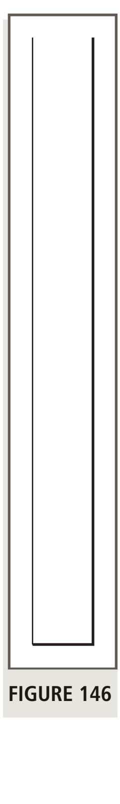


FIGURE 146 Empty digital sensor.

6 stops worth of contrast, and, as we already know, as you decrease exposure, each photographic f/stop lets in one-half the amount of light as the next one.

When photographers shoot in the camera's raw format, the sensor is able to capture 12 bits of visual information. This translates into a total of 4,096 pixel levels.

The question then is: How are these 4,096 levels of tone recorded (or in this example we could say "collected")?

The brightest light values of your subject of course make the strongest impact on your sensor, so they are the ones collected first.

- Since the sensor can record a total of 4,096 levels of tone, that means that the first and brightest stop of exposure will fill up with 1/2 of these or 2,048 pixel levels.

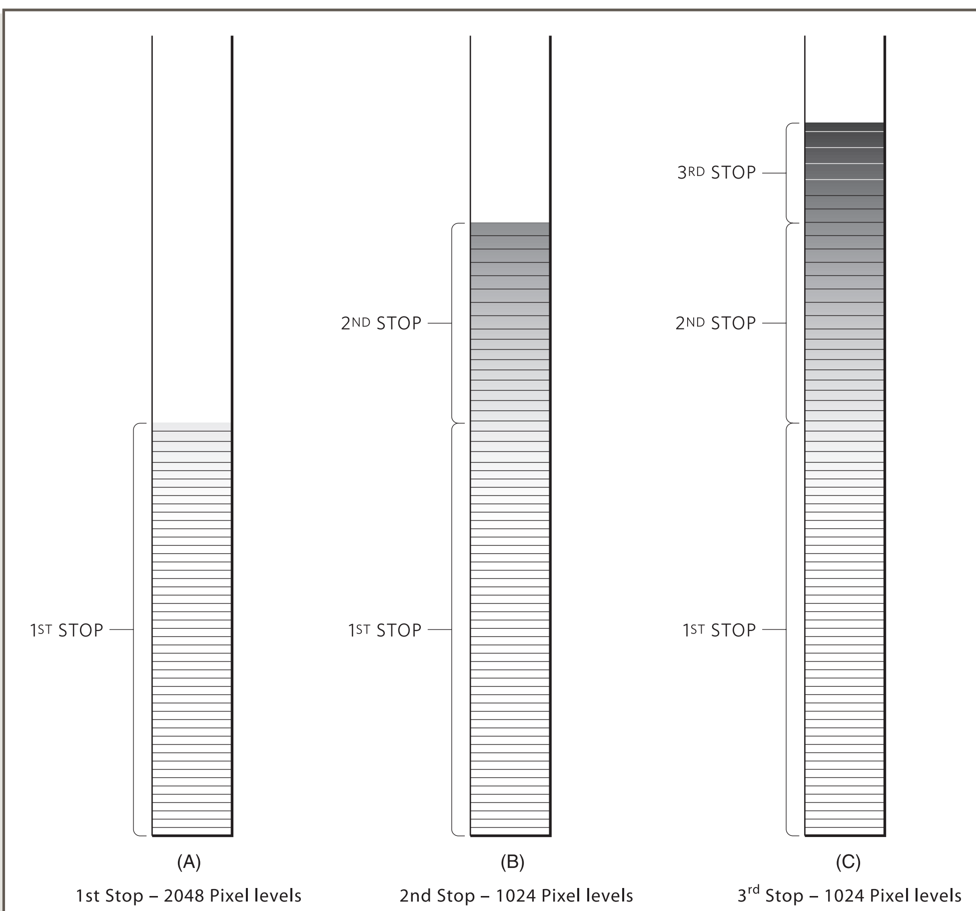


FIGURE 147 Digital sensors exposed to 1, 2, and 3 stops of exposure.

- The second stop, (tonal values that are one stop darker than the first), will fill up with 1/2 of what remains or, 1,024 pixel levels.
- The third stop fills with 1/2 of what remains or, 512 pixel levels.

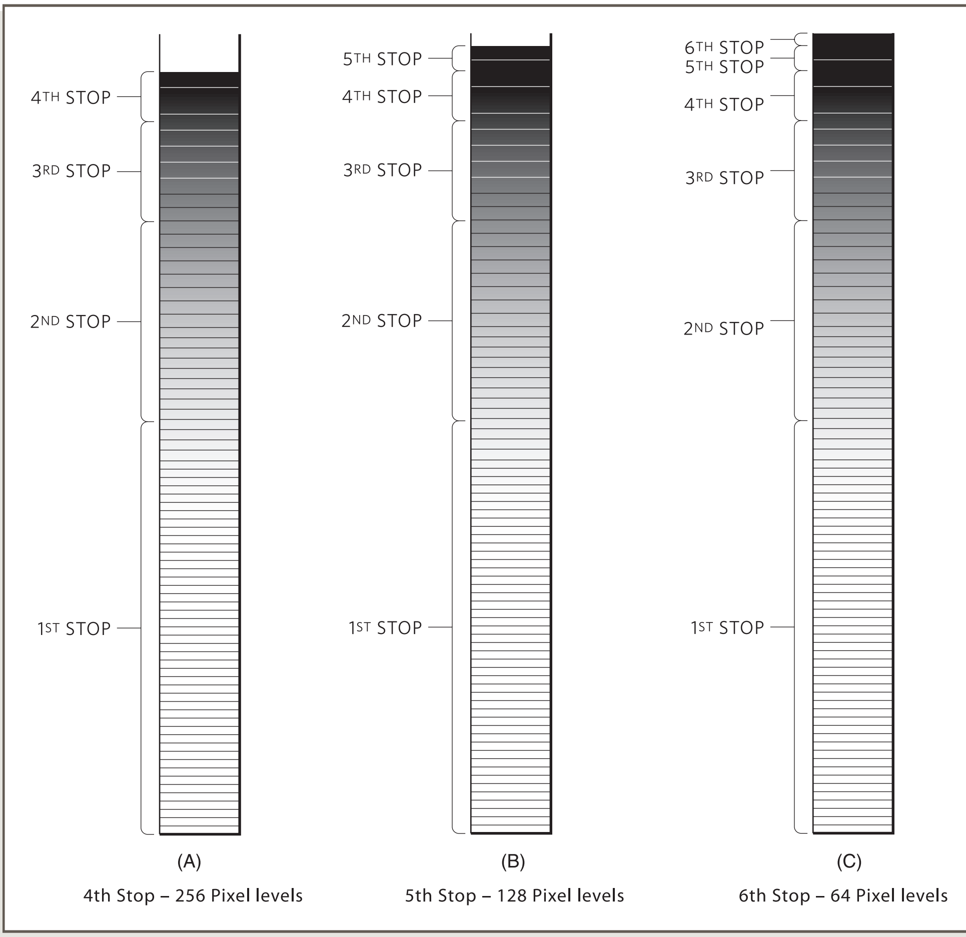


FIGURE 148 Digital sensors exposed to 4, 5, and 6 stops of exposure.

- The fourth stop has 256 levels.
- The fifth stop will have 128 levels.
- And finally, the sixth stop, the darkest, shadow values of your subject are only left with 64 levels to record them.

This Digital Linear Effect has two important implications.

First, what we have learned from this exercise is that digital chips have a natural tendency to under represent the shadow values that are so important to the quality of our images.

Because of the digital linear effect, digital cameras don't produce a tonal gradation that looks like Figure 149 with middle gray in the middle where it feels natural to our eyes.

FIGURE 149 Tone-mapped, non-linear gradation.

Instead, digital cameras produce a gradation like Figure 150 where most of the scale is devoted to the lightest tonal values and very little is left for the darkest tones.

FIGURE 150 Camera Raw linear gradation.

The difference between these two ways of measuring and rendering light values has one other extremely important implication.

In Appendix C we learned that the more pixel levels a digital image devotes to rendering a tonal gradation, the more smooth, detailed, and photo-realistic that gradation will be.

Because of the Digital Linear Effect, the number of pixel levels that digital cameras assign to the light, middle, and dark values of the spectrum aren't equal!

An equal distribution of levels across a "normal" non-linear gradient would look like this:

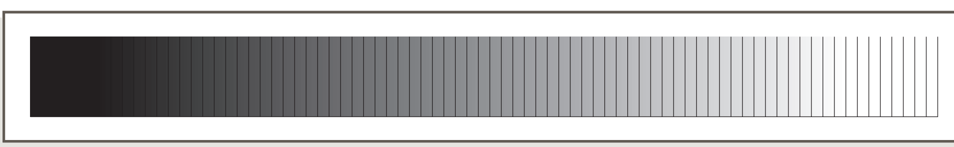


FIGURE 151 Pixel levels of a tone-mapped, non-linear gradation.

In this example the highlight, middle, and shadow values each have an equal number of pixel levels defining them.

Instead, digital camera sensors distribute pixel levels across the linear spectrum in a way that can be diagrammed like this:

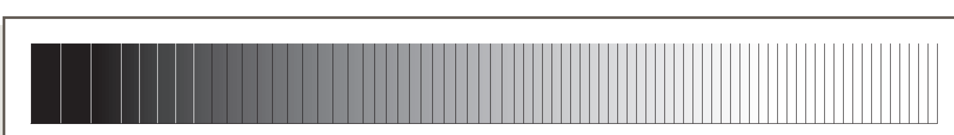


FIGURE 152 Pixel levels of a Camera Raw linear gradation.

Notice that the highlights have many more pixel levels defining them than do the middle or shadow values. This is like Figure 148(C) turned on its side.

One important function of raw conversion software is to remap the linear tonal gradation produced by digital camera to a gradation of tones that looks more natural to our eyes. This is called "Tone Mapping." This is a function that has dramatic implications for the way we should expose and process digital images.

The fact that so few levels of tone are devoted to the shadows explains why banding and posterization is such a problem when the contrast of underexposed digital images is expanded (see Figure 92).

If you properly expose digital images as explained in the section The Zone System of Digital Exposure on page 138, then your shadows will fall on exposure stops as near to the middle of the scale as is possible given the dynamic range of the image that you're shooting. This way the images will be recorded with more levels for you to work with when you edit the images in Photoshop.

Appendix E
Films, Developers, and Processing

Despite what advertising may suggest, no film or developer is ideal for every use. Developers and films all have very specific qualities that are best suited to particular applications. Your goal should be to define the kind of photography that you intend to do and decide on the appropriate materials.

As you begin this process it's easy to feel that you may never learn enough about all of the various developers and films available and their effects. There is in fact a much more direct and practical way to approach this problem. What most photographers actually do is look at the work of a photographer they admire and use the film and developer that that photographer uses, at least as a starting point for their own work. This approach not only gives you a concrete model to follow, but you also can learn the pitfalls and limitations of a particular film/developer combination.

It is for this reason that I have decided to give you as much practical information as I can about what different films and developers will do. Of course, not every available film and developer is included in this appendix, but the ones I have chosen cover most of the major products available in the United States and, more important, all of the major categories of films and developers that are made. As I mentioned at the beginning of Chapter 9, there have recently been significant changes to a number of the most revered traditional photographic products. Comments on some of these issues are included in the following sections.

The first section, The Basics, describes the general categories of films and their uses. If you're already familiar with these basic concepts, skip this section and refer to the sections Developer Notes, Film Notes, and Processing Notes for more detailed information. The section Film and Developer Questions and Answers summarizes my personal evaluations of how certain films and developers actually perform.

Once you have chosen a given developer and film, stick with them until you're sure that you understand their advantages and disadvantages; only then should you begin experimenting with different variations. In the end you will find that the simpler your tools and methods, the easier it will be for you to accomplish your photographic goals.

The Basics

Both films and developers fall into natural categories that make it easier to decide which combination is best for you.

Films

There are three basic categories of film. These depend on the quality of the grain that appears when the negative is enlarged and the speed or sensitivity of the film to light. If you aren't familiar with the relationship between ASA and image quality, refer to Appendix N and the section A Primer on Basic Photography. See a later section in this appendix for a discussion of Tabular Grain Films: T-Max and Delta.

Fine-Grain Films

If you're shooting well-lit landscapes, still lifes, or non-candid portraits with roll film, you will probably want to use a tripod and a relatively slow-speed, high-acutance fine-grain film such as Kodak T-Max 100, Ilford Delta 100, or Ilford Pan-F Plus. (Keep in mind that these recommendations are only guidelines for general use. The rule is: Anything that works in art is fair.) Slower films tend to have finer grain and more inherent contrast than films with higher ASA numbers. This is why, in situations where film speed isn't a factor, most photographers try to use as slow a film as possible.

High-Speed Films

If you're shooting in low-light situations or taking pictures of moving subjects, you'll need a faster film such as Kodak 400TX (Tri-X), 400TMax, Ilford Delta 400, or Ilford HP-5 Plus. High-speed films have more grain and less inherent contrast than films with lower ASA numbers. Those shooting with view cameras should remember that fast films like 400TX (Tri-X) are only grainy when the negative is greatly enlarged. In extreme low-light level situations where maximum film speed is the priority, films such as Kodak T-Max P3200 are ideal.

Medium-Speed Films

Medium-speed, semi-fine-grain films are designed for average situations where a high-speed or fine-grain film isn't required. Kodak 125PX (Plus-X) and Ilford FP-4 Plus are good choices.

All of these films are excellent when handled properly.

Developers

The speed and grain characteristics of various films make choosing the right one fairly simple. Selecting the best developer is more complex for two basic reasons: there are dozens of good brands and different types of developers to choose from and there is a general lack of objective information about what a particular developer will do. A good rule of thumb is: Find a photographer whose work you admire and use the developer that photographer uses.

Generally, developers fall into three basic categories: fine-grain, general purpose, and exotic.

Fine-Grain

Fine-grain developers are ideal for negatives that need to be greatly enlarged. Unfortunately, these developers tend to produce negatives that appear less sharp. They also give you less film speed than standard developers. Some recommended fine-grain developers are Acufine, Ilford Perceptol, Microphen, Kodak D-23, and Edwal FG-7 with a 9 percent solution of sodium sulfite.

General-Purpose

Standard developers are excellent for most films and ordinary lighting situations. The slightly increased grain that you get with these formulas is only a problem if you are making very large

prints. Kodak's HC-110, Ilford's Ilfotec HC, T-Max developers, and Edwal's FG-7 have the added advantage of being concentrated liquids. This eliminates having to dissolve powders in heated water before using them. Recommended standard developers: Kodak XTOL, Kodak HC-110, Kodak D-76, Edwal FG-7, Ilford ID-11, and Kodak T-Max and T-Max RS.

Exotic, Make-It-Yourself Formulas

Exotic developers are for adventuresome photographers looking for the ultimate developer for special purposes. The variety of different formulas available is staggering. For more information, consult *Basic Photographic Materials and Processes, Second Edition* (paperback), published by Focal Press; *The Negative*, by Ansel Adams; or *The Photo-Lab Index* (the last edition of this classic was published in 1994, but it's worth having if you can find a used copy).

Developer Notes

In Memoriam One very unfortunate consequence of the digital revolution is the passing of one of my favorite developers, Agfa's Rodinal. Rodinal was actually the oldest commercially produced developer in the world and the developer of choice for photographers looking for the sharpest grain and most film speed and contrast when shooting at night. T-Max developer at 75 degrees is a good alternative for pushing films. The venerable Rodinal will be greatly missed.

KODAK XTOL is a powder that comes in two-parts that can be mixed at room temperature. Designed as a general-purpose developer it gives very good film speed, fine grain, and good contrast. Be sure to mix XTOL precisely as recommended by Kodak and, although I suggest using this as a one-shot developer, it can be "self-replenishing." (See note below).

Note: All developers exhaust themselves as they are used due to the accumulation of residual by-products as you process film. Some are designed to be "one-shot" developers that you discard after using them once. Edwal FG-7 is an example. This guarantees that you're always using fresh developer, which is vital for consistent results, but this is clearly not the most economical or ecological darkroom practice. For this reason, many photographers and photo labs use developers that can be "replenished," which means that they can be brought back to full strength by adding a carefully measured amount of a special, concentrated batch of the same developer brand. "Self-replenishing" developers like Kodak's T-Max and XTOL have the advantage of allowing you to replenish them with a batch of developer mixed to the same dilution as your normal solution. You do this by simply bringing the volume of developer back to your normal amount, usually one-half or one full gallon.

KODAK D-76 is a general-purpose developer sold as a powder. It can be used either straight, as a stock solution (diluted from powder), or diluted one part stock to one part water. D-76 gives slightly finer grain and can be replenished when used straight.

ILFORD ID-11 is very similar to D-76 but gives finer grain and is good for Expansion developments.

EDWAL FG-7 is a fine-grain liquid developer that has a slight **compensating effect** (see Appendix K) when used at dilutions of 1:15 or greater. Adding sodium sulfite will reduce your development time and give you finer grain. To make a 9 percent solution of sodium sulfite, add 45 grams of sodium sulfite to 15 ounces of water. Add 1 ounce of FG-7 to make a 1:15 solution.

KODAK HC-110 is an excellent all-purpose developer that comes in liquid form, which makes it quick and easy to use. HC-110 produces negatives that are as fine-grained as those developed with Edwal FG-7 with sodium sulfite, but HC-110 provides greater contrast. HC-110 works well with Kodak T-Max P3200, giving good film speed and contrast. Kodak lists a number of dilution possibilities for HC- 110 on the bottle. Dilution B is one part stock solution to seven parts water (1:31 from concentrate).

ILFORD ILFOTEC HC (High Concentrate) is a liquid developer similar to Kodak's HC-110, although my tests show that it gives slightly less film speed.

ILFORD PERCEPTOL is a softer-working, fine-grain developer that is useful for Contraction developments because of its relatively long Normal Development Times.

KODAK T-MAX is an excellent and versatile high-energy developer designed specifically for Kodak's T-Max films. T-Max gives good contrast and film speed with any film, but it is especially good with T-Max 100 and 400 when used at 75 degrees. T-Max developer comes in a liquid stock solution that is mixed 1:4 for a working solution.

> **Note: Kodak T-Max developer isn't recommended for use with any sheet film. Occasionally a dark, blotchy coating called *dichroic fog* will appear on the emulsion side of your film and can only be removed by vigorously washing the film by hand, which carries the risk of scratching the image. Because roll films don't use the same adhesive coatings as sheet film between the emulsion and the film base, dichroic fog isn't a problem when T-Max developer is used with roll films.**

KODAK T-MAX RS developer is very similar in quality to T-Max developer except that it produces negatives with slightly more contrast.

T-Max RS is formulated to be self-replenishing. (See the note below Kodak XTOL developer.) Kodak recommends replenishing at a rate of 1 1/2 ounces per roll processed. This system is easy to use and has the advantage of making it impossible to over replenish. When the second half gallon is finished, you can assume that the developer is exhausted and ready to be replaced.

Unlike T-Max developer, T-Max RS developer is recommended for sheet film because it is designed for use in machines and contains buffers that prevent the silver from re-plating on the surface.

Film Notes

The Old vs. New Kodak Film Controversy

As I mentioned at the beginning of Chapter 9, there has been a great deal of confusion and some controversy about the extent to which Kodak's films have changed. What is clear is that Kodak's emulsions needed to be modified to accommodate the relocation of the plants they use to apply the emulsions to their film bases (or the "coating alleys" as they are known). Many photographers have discovered that prints made from these new films have more pronounced grain and harsher tonal gradations than the old films and empirical tests have confirmed these results. For reasons that aren't clear, this effect seems more dramatic when the new Kodak films are processed in Kodak D-76, a developer that was once the standard for many photographers. Our tests indicated that these new films have much better speed and contrast characteristics when processed

in Kodak XTOL and T-Max developers. This is especially true for Kodak's 100Tmax (T-Max 100) and 400Tmax (T-Max 400) films.

Tabular Grain Films: T-Max and Delta

By applying Tabular Grain or T-Grain technology to black-and-white emulsions, Kodak and Ilford have produced films that have substantially less grain than standard emulsion films. Tabular refers to the much larger and flatter shape of the silver crystals in the emulsions of these films. The greater light absorption qualities of these flat crystals allow the manufacturer to produce a thinner emulsion that results in substantially finer grain.

Kodak's T-Grain films are T-Max P3200, 400TMax, and 100TMax. Ilford's T-Grain films are Delta 100 and Delta 400. The finer grain and excellent image quality of these films will no doubt make them very popular with serious photographers, but my test results indicate that T-Max and Delta have unusual characteristics that should be given special attention.

1. I found 400TMax and 100 and Delta 400 and 100 to be no faster than 400TX (Tri-X) or 125PX (Plus-X), respectively. The advantage of T-Grain films is that they have substantially finer grain. 100TMax has grain as fine as the old Kodak film Panatomic-X, but 100TMax is much faster.

   T-Grain films are also extremely unforgiving of underexposure. 400TMax and 100TMax look best when developed in T-Max or T-Max RS developer at 75 degrees, but be sure that you place your Important Shadow Area no lower than Zone III on the scale.

   Never use T-Max developer with sheet film. See the information on Kodak T-Max under the section Developer Notes.
2. T-Grain films are extremely sensitive to changes in development time, temperature, dilution, and agitation rate. Inconsistencies in any of these variables will produce noticeable changes in the contrast of your negatives. For this reason, T-Max films are very useful for Expansion and Contraction developments. Make an effort to be as consistent as possible in your development procedures.
3. Because T-Grain films are unusually responsive to changes in development time, the normal Expansion and Contraction formulas don't apply to these films. See the section Expansion and Contraction Development Times at the end of Chapter 8 for details.
4. Kodak indicates that T-Max films require less compensation for the reciprocity effect than do conventional films. Ordinarily when your indicated exposure is 10 seconds, a 50-second exposure is required, with a 20 percent reduction in your development time to avoid underexposure and overdevelopment. With T-Max, Kodak recommends an exposure of only 15 seconds for a 10-second indicated exposure with no reduction of your development time (see Appendix O). Standard reciprocity failure charts apply to Ilford's Delta films.
5. Longer fixing and washing times are required with T-Max films to clear special dyes added to the emulsion. These dyes will turn the fixer red and exhaust it faster than normal. Ilford's "Core-Shell Crystal Technology" allows Delta 400 and 100 to have the advantages of a T-Grain emulsion without the special dyes that cause T-Max films to stain the fixing bath.

Chromogenic Films

This class of films is based on color negative developing processes. These films have characteristics that are substantially different from normal black-and-white materials. Kodak's BW400CN has a T-Grain emulsion for very fine grain and sharpness.

1. Because the image in a chromogenic negative is made up of densities of black-colored dye instead of particles of silver, they are less grainy.
2. Overexposure tends to reduce the appearance of grain because as the density of the negative increases, the microscopic spots of dye merge to form a continuous image. This allows a great range of exposure latitude when working with these films; usually ASAs between 25 and 1600 can be used on the same roll with satisfactory results.
3. Because chromogenic films must be processed to C-41 color standards, you can't alter the development time to compensate for changes in subject contrast.
4. Since chromogenic films are designed to be printed on color papers, you'll need much longer times and higher contrast settings when used on black-and-white papers.

Processing Notes

There are a number of factors that will affect your development time. Please keep the following in mind.

AGITATION. The longer and more aggressively you agitate the film in the developer, the shorter your development time will be. Consistency is very important. My agitation plan for roll film is as follows:

- Constant agitation for the first thirty seconds.
- Rest for thirty seconds.
- Agitate for five seconds for every thirty seconds up to the total development time.

(See A Primer on Basic Photography.)

DILUTION OF THE DEVELOPER. It's extremely important that you accurately measure your chemistry every time you process your film. Changing the dilution has a dramatic effect on the contrast of your negatives. Very dilute developers reduce negative contrast. Higher concentrations increase contrast. (See Appendix K.)

> **Note: Jobo processors automate the agitation process by giving the film constant agitation. For this reason your Normal Development times will be approximately 15% shorter when using these processors.**

TEMPERATURE. Once you establish a working temperature for your chemistry, make sure that you don't stray from this standard by more than one degree.

TANK VS. TRAY DEVELOPMENT. This applies to sheet film users only.

With the **tray method**, the individual sheets of film are agitated continuously by a hand in a tray of developer. Use a tray that is large enough to allow easy handling of the film. Trays with flat unchanneled bottoms aren't recommended. This method uses less developer than the tank

method, and because the agitation is constant, the processing times are shorter. Presoaking the film in a bath of 68 degree water will prevent the sheets from sticking together when you put them into the development bath. When the film is presoaked, thirty seconds should be added to the development time. Extreme care must be taken to avoid scratching the emulsion side of one piece of film with the corner of another. Also be careful not to touch a dry sheet of film with your wet fingers. The safest method for developing sheet film in a tray is as follows:

1. Fan the dry sheets so that they can be grasped individually.
2. Quickly immerse the film one shot at a time in the presoak bath face up to avoid trapping air bubbles against the emulsion.
3. When you move your film from the presoak bath to the developer, place each piece of film face down and keep the film from floating around.
4. To agitate, pull the bottom sheet out and move it to the top.
5. Keep repeating this process for the duration of the development time. Make sure that the sheets remain face down. This will protect the emulsion side of the film from being scratched.

With the **tank method**, the sheets are first put into individual metal hangers and then are developed together in an upright tank. To agitate sheet film in a tank, use the following method:

1. At the beginning of your development, slowly lower the hangers together into the development tank.
2. Tap them sharply against the top of the tank to dislodge any air bubbles that may be on the surface of the film.
3. Lift the hangers out of the developer together and tilt them to the side until the excess developer has run back into the tank.
4. Re-immerse the film and repeat step 3, tilting the hangers in the opposite direction.
5. Repeat steps 3 and 4 for the first fifteen seconds of every minute, following the agitation plan outlined above.

Proper sheet-film agitation requires careful planning and precision. Before you attempt either tray or tank development, I would suggest that you ask an experienced film processor to demonstrate how it’s done.

Whichever method you use, always use fresh developer and develop the same amount of film in your tank or tray when possible. The more film you process in a given amount of developer, the faster the developer will be exhausted.

Appendix F
The Practical Zone System Film/Developer Testing Method

Many years ago as I was learning the Zone System I went through the frustrating process of designing home film and developer testing methods that attempted to reproduce the procedures I read about in articles and technical books. This included building handmade densitometers out of wooden index card boxes and setting up lights in my musty basement; none of these approaches were either simple enough or precise enough to teach me what I wanted to know or how all of this applied to the photography I wanted to do. Eventually I learned enough by trial and error to make the system work well, but when I decided to write the first edition of this book I knew I needed a better solution to this problem.

The challenge was to create a film and developer testing method that was precise and consistent enough to give me accurate results, pragmatic enough to include all of the factors that operate for photography in the real world, and efficient enough to allow me to test many different film brands in a variety of different developers.

The following is a description of the process my collaborator and I used to prepare the test results published in this book, but first I want to acknowledge the indispensable support provided by Kodak and Ilford for their generous donation of hundreds of rolls of film over the years. Most especially I want to acknowledge Iris Davis whose custom labs have provided the setting for all of the developing and printing involved, and whose enthusiasm and patience helps make this all possible.

The Testing Process

First let's consider the objectives of this process. My goal was to see exactly how a wide variety of films behaved at a range of different ISO settings, when processed in an equally wide array of developers. A key to the success of this process was building a testing target that contained very easily identifiable swatches of all of the important Zones. Years ago I walked into a large fabric store in Austin, Texas, with my spot meter and a gray card. To create swatches of the important Zones I compared selections of very fuzzy towel fabrics until I found a set that reflected light in such a way that they fell exactly across the Zone Scale when evenly lit. (Needless to say thepro-prietors of the store were very patient with all of this strange behavior.)

Figure 153 was the result. Rough but very effective.

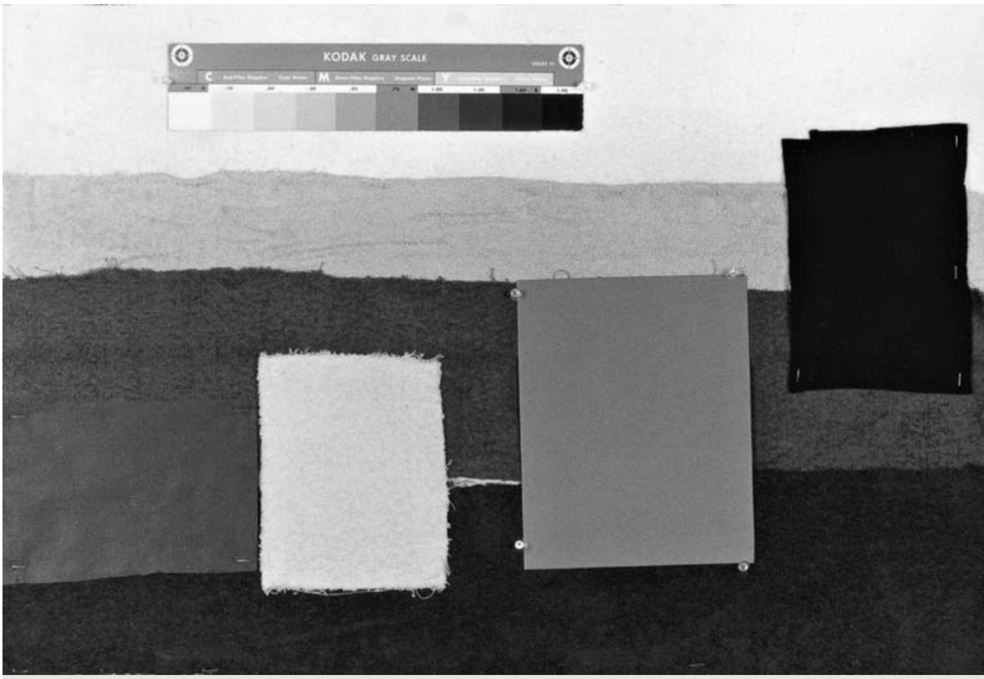


FIGURE 153 Zone System film testing target.

After acquiring all of the film and developer I needed, the next step was to set up my target in a lighting studio and make sure that my reflected meter readings all fell appropriately on the Scale. I paid special attention to the placement of Zones V, represented by the Neutral Gray Card, and the large areas of Zones III and VIII.

Once this was done and the image was focused, I proceeded to very carefully expose the requisite hundreds of rolls of film according to a precise bracketing system that was exactly equivalent to shooting the film at a range of different ASA/ISO settings. I also left a number of frames blank for reasons that will soon be clear.

Note: The principle behind this step is described in Chapter 8 in the section The Use of Equivalent ASA Numbers.

Once all the film had been shot, the next step was to make an informed guess at what development time in a given developer gave us the highest film speed that rendered adequate detail in the Zone III textured swatch.

This is a very important decision. You get very different results if your goal is simply to render the Zone V card as a specific negative density and print value. This is essentially what film manufacturers do, which goes a long way toward explaining why my test results are often different from most published standards. Exposing and developing for good detail in Zone III means that your film speed is likely to be lower than the gray card only method. The advantage of testing this way is that it's much closer to the concerns of photographers working in the real world. If, for example, your standard film speed doesn't give you acceptable detail in the shadow areas you will have the feeling of consistently underexposing your film.

Once a given roll of film had been processed, I then clipped a large section of blank film and positioned it in the negative carrier so that it only covered half of the opening, as illustrated in Figure 154.

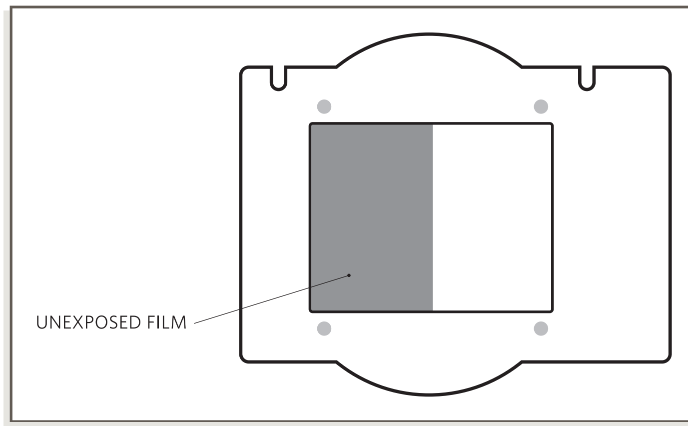


FIGURE 154 Negative carrier with blank frame half inserted.

This procedure allowed us to create a test print of short exposures where the side printed with open light turns black first, which gave us an easy way to determine the minimum time that produces the maximum black as illustrated in Figure 155.

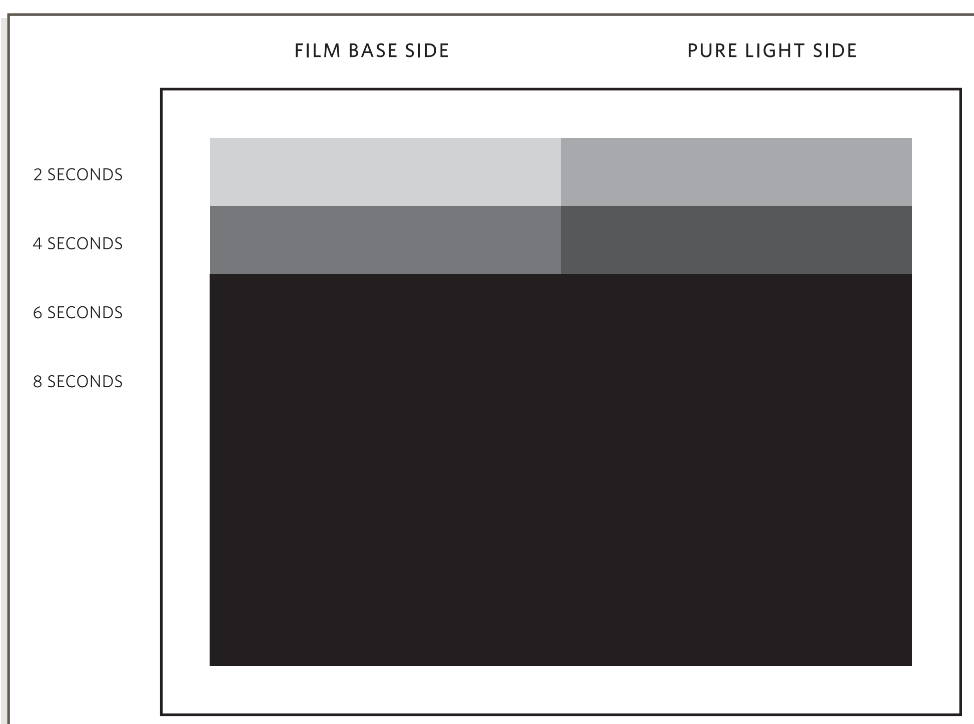


FIGURE 155 Illustration of minimum time/maximum black test.

This minimum time/maximum black test needs to be done for every test roll to compensate for the film base fog that varies from one roll of film to another. Once this time is determined, we simply make a straight print of all of the bracketed exposures using this time and look closely to see which ASA gives us the detail we want in the Zone III area of the target. Because the test prints were all exposed for the same amount of time, but were shot at different equivalent ASA settings, it's very easy to see which film speed renders the shadow textures the way we want them to be. We then label these prints with all of the relevant information. See Figure 156.

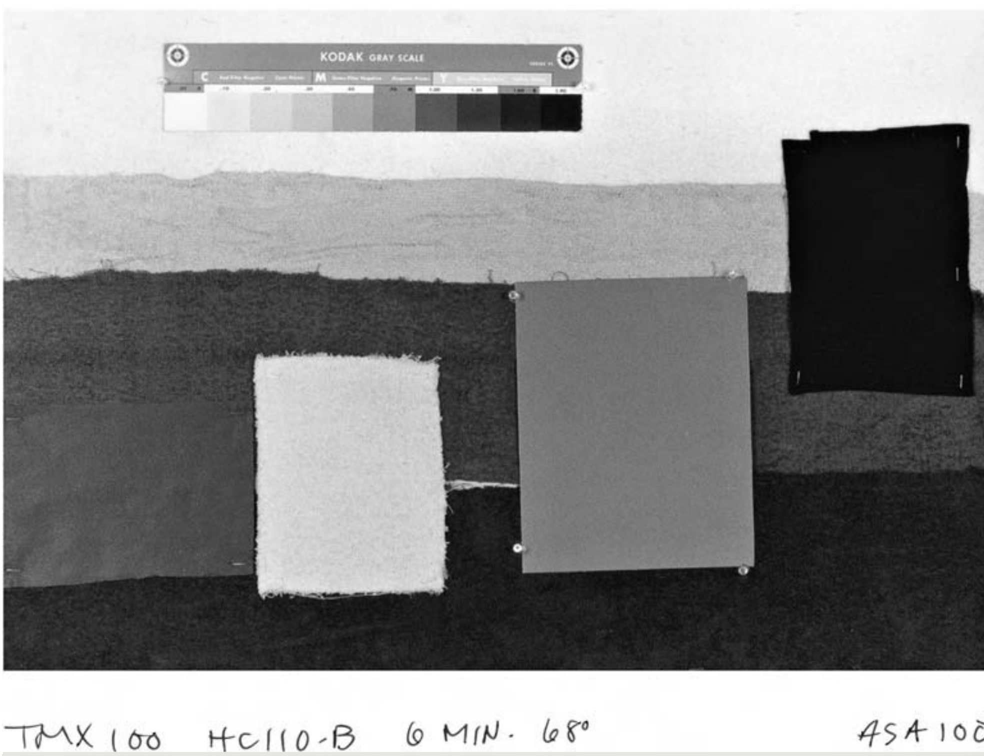


FIGURE 156 Zone System film/developer test print.

If the Zone VIII swatch of this print has good texture and detail then we knew that the development time used for that roll was our new Normal Development time for that film and developer combination. If not then we would have to go back and process one of the many backup rolls for a longer or shorter time until the highlights were rendered properly.

One advantage of this approach to film developer testing is that even the bad prints are useful for determining the Normal Plus and Minus times.

As you can see, this variation on the Zone System Testing Method 1 in Chapter 8 is designed for mass production but the principles are the same. As time- and labor-consuming as this can be, it yields a tremendous amount of valuable information.

Appendix G
Film and Developer Commentary by Iris Davis

Even More Fun With Film

Waiting 13 years to update our comprehensive film tests of 1992 might seem like a long time to anyone who's never suffered through this kind of torture. Imagine shooting nearly 200 rolls of film of the same subject: a corkboard with towels in varying colors that correspond with a grey scale. Are your eyes glazing over yet? Now, imagine processing all this film in ten different developers and then doing it over, because manufacturers recommendations are rarely related to one's own darkroom experiences. For the three of you who are still with me on this, imagine doing all of it with your ex-wife!

It is a symbol of our commitment to traditional photography, FILM, that my former husband and I braved the close quarters of a darkroom for untold hours to try and make sense of the changes Kodak and Ilford have made to their products over the last few years. We wanted to see if, as we suspected, Tri-X was no longer "God's film" and whether or not we should just hang it up and go digital. (Obviously, this is not an option for me, as I am way too stubborn to give up on a fine print that can only be made by getting one's hands wet.)

A question I found myself asking repeatedly during our first round of film testing in 1992 crept back into my mind during these exhaustive rounds as well: Who tests this stuff, anyway? As just one example of the difference between manufacturers recommendations and our "real world" results, Ilford's development times for PanF+ in every single developer we used were consistently much shorter than the film needed.

PanF+ and Tmax 100 are the two finest grained films we tested, although Delta 100 does give them both a run for their money. As with our tests in 1992, I still can't see a reason to shoot a 50 ASA film when you can get grain just as fine and 100 ASA. I was stunned by the results of Tmax 100 in HC110 dilution B. I didn't expect to see finer grain and better contrast combined with more film speed in HC110, but that's just what we got.

In 1992 we found that Tmax 100 looked very muddy in just about every developer except Tmax, but that was not the case this time. In fact, we got a true 100 ASA out of Tmax 100 in 4 different developers and 80 ASA in several others. Delta 100 really is almost as good as Tmax 100. It gives you a good 100 ASA in FG7 with a 9% sodium sulfite solution and a very nice 80 ASA in Ilfotec HC diluted 1:31. And since Ilford has shown a much stronger commitment to traditional photography recently than just about any other film manufacturer, I'm happy to highly

recommend their films.* But in the case of fine grain and film speed, I still prefer the look of Tmax 100. One thing to note about Tmax 100 is its propensity to get dichroic fog. Tmax 100 processed in Tmax developer (not Tmax RS, by the way) is much more likely to have this nasty stuff than any other film I've ever processed. With the new results in HC110, I don't expect this to be a problem anymore.

We weren't able to get a true 125 ASA out of 125PX or FP4+ in any developer we tested. The best 125PX ever looked was rated at 64 and processed in XTOL. It was flat and ugly in everything else. Ilford's FP4+ was only marginally better. Again, almost all of Ilford's recommended processing times were considerably shorter than necessary for good contrast. FP4+ does have very fine grain when rated at ASA 64 and processed in XTOL, but again, when you can get a true film speed of 100 with Tmax 100 processed in HC110, why give up half a stop?

Thirteen years ago we rated Tri-X at ASA 400 in 5 of the 10 developers we tested. In this round of testing we didn't get a good 400 for Tri-X in one single developer. We found it to be a very good 320 in Ilfotec HC and FG7 with a 9% sodium sulfite solution and HC110 dilution B. The grain was noticeably finer in Ilfotec HC, but HP5+ stole the show this time around. Certainly, if you're attached to Kodak (and I can't believe I'm saying this) you'll want to choose Tmax 400 over Tri-X. Kodak appears to be more committed to their Tmax films than Tri-X and Plus-X. Is it just too cynical to think they've found a cheaper way to manufacture these films? Whatever changes they've made to Tri-X and Plus-X haven't been beneficial to the working photographer.

While Tmax 400 does, indeed, give you a good 400 ASA in several developers, there's just something missing. At its best, Tmax 400 just seems to lie there on the paper. HP5+, on the other hand, looks quite good in a number of developers. In my real-world experience I rate HP5+ at 320 and process it for 10 minutes in XTOL, and that's proof that these processing times should be considered starting points for your own tests. I am convinced, however, that any conscientious photographer will get acceptable results with the times outlined in this book, and I'll be happy to show you the dozens of ugly 8 x 10 test prints to prove manufacturers don't work in a darkroom anything like yours or mine.

I've seen mixed results with Delta 400. Our tests showed it to be a beautiful 400 when processed in XTOL, but the film that has come through my lab has looked consistently underexposed. I am very surprised that Ilford's films don't seem to perform any better, and often not as well, in their own developers. While Delta 400 looks quite good in XTOL diluted 1:1 and even Perceptol used straight (rated at 400 and 320, respectively), there's nothing at all special about the results you get in Ilfotec HC or ID-11. It's also interesting to note that Ilford is now recommending ID-11 be used straight rather than diluted 1:1 as we did in 1992.

We tested Delta 3200 and Tmax 3200 in just a few developers. Obviously, some developers with very long times were out of the question for our "practical" results. We gave them both a

* After we were too far into this to add any more film to our tests, Fuji came out with a refreshing press release stating their commitment to traditional photography: *Silver halide photography, which is fundamental to photography, has advantages over digital in such areas as power of expression, long term storage capability, reasonable prices, easy handling and a highly established and convenient photo development and print infrastructure.*

We intend to continue our silver halide photography business and to further cultivate the culture of photography, and in so doing, continue to support our customers and retailers and all those who enjoy photography.

shot in XTOL straight, hoping for decent film speed without giant grain. No luck with Delta 3200, but Tmax 3200 gave us relatively fine grain and an effective ASA of 1600. Based on some of my own clients' results pushing HP5+ to 1600, we tried that too. We were able to get an acceptable 1600 ASA with HP5+ processed in Tmax developer at 75° for 8 minutes, and finer grain than either of the 3200 films. While we did get an actual film speed of 3200 ASA with the Tmax film processed in Ilfotec HC 1:31, we decided Tmax RS gave us a good 2400 with finer grain.

After months of shooting and processing film in all these developers, comparing shadow and highlight detail, grain structure and effective film speeds, it was finally enough to get my teatotalling former husband to share a bottle of champagne with me. Everything looked much better after that.

Iris Davis, with unique style and class, owns and operates a quality custom photo lab in Oakland called Davis Black and White. She welcomes questions and comments through her web site: www.davisblackandwhite.com/.

APPENDIX H

Alternative Methods for Extreme Expansion and Contraction Development

Expansion

With modern films and developers, Expansions beyond N + 2 are difficult to achieve without a serious loss of image quality owing to increased grain and fog. In general, you should rely on higher than normal paper grades and/or negative intensification when extreme Expansion is required.

Intensification means processing the film through a special chemical bath with the intention of increasing the contrast of the negative after it has been developed and fixed. Ideally, intensification will add density to the highlight areas of the negative without greatly increasing grain. Photographer's Formulary offers a prepared formula called Chromium Intensifier that requires you to bleach, intensify, and then redevelop your negative. This is effective, but a more simple method is to intensify the negative in a bath of selenium toner. To intensify negatives in selenium:

1. Presoak the negative in a bath of water for five to ten minutes.
2. Re-fix in a bath of hypo without hardener for five minutes.
3. Tone in a bath of Kodak Rapid Selenium Toner diluted 1:3 with hypo clearing agent for five minutes. Agitate continuously.
4. Clear in hypo clear and wash.

Note: Selenium toner is highly toxic. This procedure should be done in a well-ventilated area. Read the instructions carefully.

Contraction

There are a number of techniques available when extreme Contraction is necessary to control the contrast of a very high contrast subject.

1. You may have to use a lower than normal paper grade.
2. If used properly a **compensating developer** will lower negative contrast while minimizing the loss of shadow detail.
3. The **Two-Bath** and **Water Bath** development techniques can sometimes be useful for extreme Contractions.

All of these processes are described in detail below.

It's important to remember that there will always be some loss of shadow detail when Contractions beyond N − 2 are necessary. This can be compensated for by placing your Important Shadow Area on Zone III 1/2 or Zone IV when you are planning an extreme Contraction.

Appendix I
Contrast Control with Paper Grades

For historical and technical reasons, paper grade 2 (or variable contrast filter 2, or the equivalent mix of blue and green light on variable contrast heads) is usually considered Normal for negatives with Normal contrast. For example, this is the grade of paper I used as the standard for my testing procedure (see Chapter 9). This means that paper grade 2 would become the target of all of your Zone System negative contrast adjustments, and theoretically your negatives would print well on that grade.

On the other hand, it is possible to customize your Normal Development Time so that any grade of paper becomes Normal for you when you use a given film/developer combination. Experienced fine printers often do this because they have learned that a particular grade of paper best suits their aesthetic needs.

The general principles for adapting your Normal Development Time to fit a given grade of paper are discussed below.

When compared to a standard Normal Development Time on grade 2, the higher the grade of paper you choose as your personal normal grade, the shorter your personal Normal Development Time will be with a given film/developer combination. This is because paper grades with more contrast (higher grade) require negatives with less contrast (a shorter Normal time).

Conversely, the lower the grade of paper you choose as your personal Normal grade, the longer your personal Normal Development Time will be for a given film/developer combination.

This is because paper grades with less contrast (lower grade) require negatives with more contrast (longer Normal time).

Of course there are practical limits to how far you can take this process, and the only way to know precisely how much shorter or longer your time should be is to carefully do a test like the one outlined in Chapter 8 (page 78).

Once you've established your personal Normal grade of paper, and a corresponding personal Normal Development Time, it becomes possible to use paper grades that are higher or lower than this new Normal grade to achieve contrast control beyond the usual Expansion and Contraction methods described in this book: one grade higher than your Normal grade is roughly equivalent to the effect of N + 1; one grade lower than your Normal grade is roughly equivalent to the effect of N − 1.

Note: The type of enlarger you use is also a factor in this process. The same negative will produce a print with approximately one grade more contrast when printed with a condenser enlarger than with a diffusion or cold-light enlarger (see Appendix M).

My recommendations here are hedged because paper grade numbers aren't strictly standardized among manufacturers. Printing the same negative on grade 3 of one brand of paper may give you the same contrast as grade 4 of another brand. This use of higher and lower paper grades can enhance the effect of Expansion and Contraction.

For example, if you are photographing a subject that you determine requires N + 3 development, which is beyond the range of normal Expansion techniques, you should give the negative N + 2 development and then print that negative on a grade of paper that is one grade higher than your personal normal grade. This will result in a print that is approximately equivalent to N + 3.

Conversely, if you are photographing a subject that you determine requires N − 3 development, which is beyond the range of normal Contraction techniques, you should give the negative N − 2 development and then print that negative on a grade of paper that is one grade lower than your personal Normal grade. This will result in a print that is approximately equivalent to N − 3.

Careful testing is required to perfect this technique with your preferred materials. One reason that paper grade 2 or filter 2 is generally considered best for your Normal standard is that it's in the middle of the range of contrast choices available with most papers. Standardizing your negatives to grade 2 will give you the widest number of choices above and below that grade for creative contrast control.

Appendix J
Developer Dilution

A number of film developers are specifically formulated to work well at a variety of dilutions. The following is a list of some popular developers and the dilutions at which they are commonly used:

Edwal FG7	1:3 to 1:15
Kodak HC110	1:3 to 1:30
Ilford Ilfotec HC	1:31 to 1:47
Kodak D76	1:1 or undiluted

Recommended Normal Development Times and mixing instructions are provided with all these formulas.

Changing the dilution of a given developer has a dramatic effect on its characteristics and performance. As a general rule, developers that are more dilute produce negatives with softer tonal gradations and finer grain. Diluted developers are ideal for Contraction developments because of their relatively longer development times and because of the compensating effect (see Appendix E). In general, diluted developers can't be reused, and you may notice some loss of effective film speed, causing you to use a lower ASA.

Negatives developed in more concentrated "high-energy" developers tend to have greater tonal separations and coarser grain. Concentrated developers are recommended for Expansions because their Normal Development Times are relatively short. These developers will generally allow you to use a higher ASA for a given film than developers that are less energetic.

Developers containing high concentrations of sodium sulfite (D76, XTOL, Perceptol, ID-11, and Microdol-X) produce finer grain when used in their undiluted form. In high enough concentrations, sodium sulfite will act as a silver solvent and reduce graininess at the expense of image resolution.

Appendix K
Compensating Developers

These are very dilute, slow-working developers that take advantage of the fact that denser areas of the negative (the highlights) exhaust developer at a faster rate than thinner areas. This is because the highlight areas contain more exposed silver.

As the film develops, residual by-products (bromide ions) produced in the emulsion weaken the effect of the developer and slow the process. The function of agitation is to replace the weakened developer with fresh supplies. When the film is at rest between agitations in a compensating developer, the bromide ions build up at a much faster rate in the highlight densities of the emulsion than they do in the less dense shadow areas. This effect is exaggerated because a compensating developer is relatively dilute and therefore is less able to replace the exhausted developer saturated in the emulsion. This causes the highlights to increase in density at a much slower rate than the shadow areas. The shadows, in effect, are given a chance to increase in density, resulting in an overall decrease in contrast and better shadow detail.

Compensating Formulas

The following is a list of some popular compensating developers. See Appendix S for references to other developer formulas.

Kodak HC110, diluted 1:30 (from stock not the syrup). Average Normal Development Time: 25 minutes.

Edwal FG7, diluted 1:15 (without sodium sulfite). Average Normal Development Time: 10 minutes.

You should conduct your own tests with these developers to discover the correct times for your film.

Kodak D-23

If you're ambitious and have a decent scale for weighing chemistry, Kodak D-23 is a formula you can mix yourself. The ingredients are available from any chemical supply company or from Photographer's Formulary (see Appendix T). Follow the formula for D-23 carefully and mix the ingredients in the order given.

Water (125°F)	750 ml
Metol	7.5 g
Sodium sulfite	100 g
Water to make	1000 ml

The working temperature of D-23 is 68 degrees.

Two-Bath Compensating Formula

The Two-Bath method was made popular by Ansel Adams for extreme Contractions. It utilizes Kodak's D-23 formula listed above as part A, and the following formula as part B.

Two-Bath Formula: Part B

Water (125°F)	100 ml
Borax (granular)	20 g
Water to make	1000 ml

The working temperature is 68 degrees.

The procedure for using this Two-Bath formula is as follows:

1. Agitate the film continuously for four minutes in part A (D-23).
2. Move your film to part B and let it rest there, without agitation, for three minutes.

The result of the Two-Bath method should be contrast reduction equal to approximately N − 2. Two-Bath developer processes work because of the compensating effect described above. A classic variation of this procedure is the water bath development process.

Water Bath Development

This technique was designed to dramatically reduce negative contrast with a minimal loss of shadow detail. It works best with sheet films because it assumes that there will be enough developer saturated into the shadow areas of the emulsion to allow them to continue developing after the highlight areas have exhausted their developer.

It should be noted that, in an effort to improve sharpness and reduce grain, film manufacturers have reduced the thickness of most modern 35 mm film emulsions to a point where water bath development no longer works as well as it once did with roll film.

The basic technique for Water Bath Development is as follows:

1. Agitate your film in the developer bath continuously for thirty seconds.
2. Quickly transfer the film without draining it to a bath of water and let it sit without agitation for one minute.
3. Repeat these steps three times and then process, wash, and dry your film normally.

Any standard developer will work with this process, but see the web site http://www.digitaltruth.com/store/formulary_tech/01-0190.pdf for information on the use of this technique with Amidol, one of the classic developers from the era of Edward Weston.

Appendix L
Inspection Development

This classic technique allows you to examine the film for a few seconds while it is developing using a very dark green Kodak Safelight filter 3. The purpose is to give photographers an empirical method of determining when the negative's highlights are developed to the proper density. The film has to be at least two-thirds developed before you can safely turn on the light without danger of fogging the film. Read the directions that come with the filter very carefully.

Developing by inspection can be a useful technique to learn, but it takes a considerable amount of practice to master it. Modern films have thin emulsions and anti-halation dyes in the backing, making it difficult to see more than dark shapes in the short time allowed.

Appendix M
Condenser and Diffusion Enlargers

The function of an enlarging light source is to provide enough light to cast the shadow of the negative onto the printing paper. Condenser and diffusion enlargers differ in terms of the quantity and the quality of the light they present to the negative.

The light from a **condenser enlarger** is usually provided by a tungsten bulb. The light from this bulb is focused on the negative through a series of large lenses called condensers. This focused light strikes the film in very straight, or collimated, rays.

The effect of a **diffusion enlarger** is much different. The light source is usually a fluorescent tube patterned into a grid. These tubes give off very little heat and thus are nicknamed cold lights. The light from this grid is diffused through a piece of translucent glass or plastic so that the light striking the negative is scattered as much as possible.

When light passes through a negative, it is scattered by the density of silver in the emulsion. The greater the density, the more the light is scattered. This is called the **Callier effect.** Collimated light from a condenser enlarger exaggerates this effect, giving the print more overall contrast and greater tonal separation. Because diffusion enlargers scatter the light more evenly across the surface of the emulsion, they render the true contrast of the negative more faithfully.

The advantages and disadvantages of condenser versus diffusion light sources can be summarized as follows.

CONDENSER ENLARGERS. The more a negative is enlarged, the more contrast is lost due to the scattering of light between the enlarging lens and the printing paper. Condenser enlargers compensate for this to a certain extent, which makes them very useful for printing small negatives, but there is a noticeable loss of tonal gradations, especially in the highlight areas of the print. Grain and dust are also more apparent with condenser enlargers. The extra contrast you can expect from condenser-enlarging light sources means that your Normal Development Times will be shorter when compared to photographers printing with diffusion enlargers. It usually requires approximately 15% less development to compensate for this factor.

DIFFUSION ENLARGERS. As a rule, diffusion enlargers require that you produce negatives with more contrast than if you were printing with a condenser enlarger. This means that your Normal Development Time is likely to be longer. They are also dimmer and thus require slightly longer printing times. On the other hand, diffusion light sources render much more subtle tonal gradations in the highlights and obscure dust and scratches. This makes them ideal for printing medium- or large-format negatives. Add 15% to your Normal Development Times if you switch from printing with a condenser enlarger.

Appendix N
ASA/ISO Numbers

Four interrelated numbering systems are commonly used to rate the speed of various films. This can be confusing if you don't understand how these numbers correlate with one another, but it's really very simple.

ASA numbers increase geometrically as the film speed increases. As the speed doubles, the ASA number also doubles. When compared to a film rated ASA 200, a film rated ASA 400 requires one-half the exposure (one f/stop less exposure) to produce a given density. Because of this logical relationship, and because ASA is still in common usage, I use ASA numbers as a reference for film speed throughout this book. ASA stands for the American Standards Association, now known as the American National Standards Institute.

DIN numbers are the European standard for film-speed rating. DIN numbers progress logarithmically. As the film speed doubles, the DIN number increases by three.

ISO numbers combine ASA and DIN into one number. For example, Tri-X is rated ASA 400, DIN 27, and ISO 400/27.

EI stands for Exposure Index. These numbers are used in the same way as ASA numbers but indicate that the user determined the film speed through a testing procedure.

Appendix O
Filter Factors, The Reciprocity Effect, and Bellows Extension Factors

All of these factors greatly affect your exposure.

Filter Factors

Colored filters are useful for increasing the contrast between objects that are different colors. A filter will transmit its own color and absorb its complementary color. Thus a red filter will lighten a red apple when used with black-and-white film and darken a blue sky. Filters can produce important effects, but it is necessary to remember that the filter is blocking some of the light that would otherwise be exposing the film. Unless you compensate for this lost light, the negative will be underexposed. Every filter is associated with a number called a **filter factor.** This number indicates how much exposure to add for each filter. For example, if the factor for a given filter is 2, the exposure must be increased by two times to get the proper exposure. Since each f/stop doubles the exposure as it opens up, a filter factor of 2 requires opening up one stop. A filter factor of 4 would require a two-stop adjustment. Because daylight has a bluish cast and tungsten light is reddish, the filter factors for daylight are slightly higher. (The one exception is a dark blue filter, #47, which has a higher tungsten filter factor number.) Filter factors are listed in the Kodak data guides for filters and black-and-white films.

The Reciprocity Effect

Ordinarily, f/stops and shutter speeds have an equal effect on exposure. Changing the f/stop from f/8 to f/11 is equivalent to changing the shutter speed from 1/60 to 1/125 of a second. In either case, the exposure is one stop less. This is because f/stops and shutter speeds are calibrated to be equivalent, or "reciprocal." Unfortunately, this is true only within a certain range of exposure times (camera shutter speeds). If your exposure is longer than 1/2 of a second or shorter than 1/1000 of a second, the reciprocity rule "fails."

For example, a negative exposed for 1/2 of a second at f/2.8 will give lower densities than one exposed for four seconds at f/8. The film will be underexposed even though, according to your light meter, these two exposures should be the same. This is called **reciprocity failure.** Assuming that you need to use f/8 for depth of field, the solution would be to use an exposure of f/8 at 15–20 seconds. If this sounds imprecise, you will find that published reciprocity charts are very general. It's also necessary to compensate for the increase in contrast that results from such long

exposures. Ten to thirty percent less development will be required for negatives that have been exposed for longer than 1/2 of a second.

Because of their unique grain structure, Kodak TMax films require less compensation for the reciprocity effect than conventional films. As stated above, with standard grain films, when your indicated exposure is 10 seconds, a 50-second exposure is required, with a 20 percent reduction in your development time to avoid underexposure and overdevelopment. With TMax, Kodak recommends an exposure of only 15 seconds for a 10-second indicated exposure with no reduction of your development time. Standard reciprocity failure charts apply to Ilford's Delta films.

For more information on the reciprocity effect, consult Kodak Professional Black and White Films data book, or *Photographic Materials and Processes* published by Focal Press.

Bellows Extension Factors

To focus on an object very close to the lens, it is necessary to increase the distance between the lens and the film. This is important to know because if the film – lens distance becomes greater than the focal length of the lens, the f/stop numbers become inaccurate.

An interesting way to visualize why this happens is to imagine that you're inside a large camera that is focused on an object approaching the lens. If the lens is set at f/11, as the lens gets farther away from the film, the size of aperture f/11 will appear to decrease. Eventually, f/11 will appear to be the size of f/22 from the film's point of view. The rule is: As the lens-to-film distance increases, the effect of a given f/stop will decrease. Unless you compensate for this, the negative will be underexposed when you use extension tubes on a 35 mm camera or extend the bellows of a view camera beyond the focal length of the lens.

The bellows extension factor tells you how much exposure to add to get good results when doing close-up photography. There is a mathematical formula that can be used to compute this factor, but an easier way to figure it out is to use one of the many handy devices that have been developed especially for this purpose. Two examples are the Quick Stick, manufactured by Visual Departures in New York, and the Calumet Exposure Calculator.

Appendix P
A Compensation Method for Inaccurate Meters

Light-meter accuracy and consistency are essential for good results. Many large camera stores and repair shops will run a simple “known light source” test on your meter for a small charge. If the test indicates that your meter is reading one-half to one stop under or over normal and can’t be adjusted for some reason, you can compensate for this by using an alternative ASA number. For example, if the meter is supposed to read f/5.6 at 1/125 set at ASA 400, but instead reads f/4 at 1/125, simply reset the ASA to 800. The meter will now register accurate exposures, and from now on ASA 800 will represent ASA 400 when that meter is used. To help you remember to double the ASA, tape a reminder to the outside of the meter.

This method will work if the meter is inaccurate by the same amount throughout the scale. If it’s off by different amounts on the high and low ends of its range, leave it at the repair shop.

Appendix Q
Zone System Metering Form

(See below for instructions)

Using the Zone System with In-Camera Meters

The following is a simple method for measuring the contrast and determining the proper exposure for your subject using built-in camera meters.

1. First previsualize the Important Shadow, (usually Zone III) and the Important Highlight (usually Zone VII) areas of your subject.
2. Meter both of these areas using either an aperture or a shutter speed as a reference; For example your two meter readings might be:
   Important Shadow area.............1/30 @ F/5.6
   Important Highlight area...........1/30 @ F/22
   In this example, the shutter speed of 1/30 is your Reference Reading; the two apertures are your Measurement Readings.
3. Write your reference reading in the box provided for that purpose near the bottom of the form.
4. Write the Shadow Measurement Reading under the Zone III (or II) box and fill in the other readings under the corresponding Zones where they automatically Fall after the Shadow Reading is Placed where you want it to be.
   For example: If you write the F/5.6 Measurement Reading on Zone III, F/8 will Fall on Zone IV, and F/11 on Zone V, etc.
5. If the Measurement Reading for your Important Highlight falls on the Zone you previsualized for it (usually Zone VII), use Normal Development.
   If it Falls one Zone too high use N − 1. If it is one Zone too low use N + 1, etc.
6. The Measurement Reading that Falls on Zone V, plus the Reference Reading, is the correct exposure for that placement.
   In this example the correct exposure would be **F/11 @ 1/30;** or an equivalent exposure like **F/5.6 @ 1/125.** See Figure 157.

APERATURES	F/64	F/45	F/32	F/22	F/16	F/11	F/8	F/5.6	F/4	F/2.8
SHUTTER SPEEDS	1/250	1/125	1/60	1/30	1/15	1/8	1/4	1/2	1 sec.	2 sec.

ZONES	0	I	II	III	IV	V	VI	VII	VIII	IX
						N+2	N+1	N	N-1	N-2
MEASUREMENT READINGS (2 SETS)										

REFERENCE READING

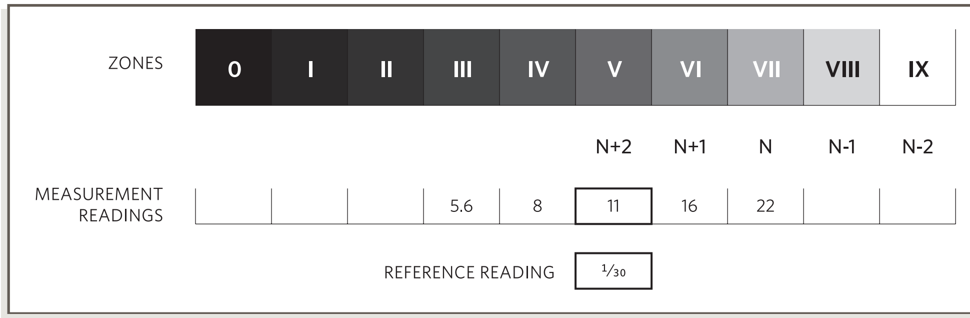


FIGURE 157 Metering Form example.

Appendix R
Exposure Record and Checklist For Zone System Testing

(See the following three pages)

EXPOSURE RECORD

FILM: ____________________

					ZONES						A	B	C	
SUBJECT	0	I	II	III	IV	V	VI	VII	VIII	IX	S SPEED	F STOP	ASA	DEV
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Instructions for sheet film are enclosed in boxes.

Check off each step as you proceed through the test.

Materials

- ☐ Camera
- ☐ 4 rolls of film
- ☐ Developer
- ☐ Tripod
- ☐ Reflected-light meter
- ☐ Cable release

- ☐ **Developer**
- ☐ **24 sheets of film**
- ☐ **12 film holders**
- ☐ **Large note pad**
- ☐ **Marker**

- ☐ Paper (your normal grade and size)
- ☐ Neutral Gray Card

☐ **Step 1** Draw your test subject above the Exposure Record.

☐ **Step 2** Meter your Zone II, III, V, VII, and VIII areas and fill in these values on your sketch.

☐ **Step 3** Enter your readings on the Exposure Record. Place the Important Shadow Area on Zone III. Does the Zone VII reading fall on Zone VII?

- ☐ Yes (go to next step)
- ☐ No (find another subject)

☐ **Step 4** Set up camera. Put a Neutral Gray Card in the image area. Does the Neutral Gray Card reading fall on Zone V?

- ☐ Yes (go to next step)
- ☐ No (move the card)

☐ **Step 5** Calculate your exposures and fill in The Exposure Record with the appropriate readings.

- ☐ Plan A (roll film)
- ☐ Plan B (sheet film)

☐ **Step 6** Recheck your meter readings. Have they changed?

- ☐ Yes (go to step 2)
- ☐ No (go to the next step)

Roll Film

☐ **Step 7**
- ☐ a. Expose one roll using the exposures noted on the Exposure Record.
- ☐ b. Recheck the meter readings and expose rolls 2, 3, and 4 using the same exposures.

Sheet Film

☐ **Step 7**

☐ a. Place the note pad in the image.
☐ b. In large letters, write 1A on the pad.
☐ c. Expose the #1 sheets of sets A, B, C, and D using the #1 exposure noted on the Exposure Record.
Did you change the **letter** for each exposure?
☐ Yes (go to next step)
☐ d. Write 2A on the note pad.
☐ e. Expose the #2 sheets of sets A, B, C, and D using the #2 exposure noted on the Exposure Record.
Did you change the **letter** for each exposure?
☐ Yes (go to next step)
☐ f. Repeat the above procedure for sheets 3, 4, and 5.

Consult Chapter 8, "Zone System Testing: Method 1," for instructions to complete steps 8–12.

Appendix S

Suggested Reading

Film Photography

Basic Photography Technique

Photography
London and Upton
Prentice Hall

Basic Photography
M. J. Langford
Focal Press

The Ansel Adams Photography Series

Ansel Adams
Bullfinch Press

Technical Resource Books

Basic Photographic Materials and Processes
Stroebel, Compton, Current, Zakia
Focal Press

The Focal Encyclopedia of Photography
Richard Zakia & Leslie Stroebel
Focal Press

On the Zone System

Beyond the Zone System
Phil Davis
Focal Press
The Zone System for 35 mm Photographers

A Basic Guide to Exposure Control
Carson Graves
Focal Press

The Zone System Craftbook
John Charles Woods
Brown and Benchmark

Digital Photography

Real World Color Management
Bruce Fraser, Chris Murphy and Fred Bunting
Peachpit Press

Real World Camera Raw with Adobe Photoshop CS2
Bruce Fraser
Peachpit Press

Adobe Photoshop CS2 for Photographers
Martin Evening
Peachpit Press

Macromedia Flash MX 2004 Hands-on-Training
Rosanna Yeung w/Lynda Weiman
lynda.com/books

Real World Adobe Photoshop CS2
Bruce Fraser and David Blatner
Peachpit Press

Photoshop Masking & Compositing
Katrin Eismann
New Riders

Photoshop CS2 Essential Skill
Mark Galer, Philip Andrews
Focal Press

Color Management for Photographers
Andrew Rodney
Focal Press

Making Digital Negatives for Contact Printing
Dan Burkholder
Bladed Iris Press

Creativity and Ideas

On Photography
Susan Sontag
Picador

Ways of Seeing
John Berger
Penguin

On Being a Photographer
David Hurn and Bill Jay
LensWork Press

Looking at Photographs
John Szarkowski
Museum of Modern Art

Camera Lucida
Roland Barthes
Hill and Wang

Light Readings
A.D. Coleman
University of New Mexico Press

The Daybooks of Edward Weston
Edward Weston
Aperture

Art & Fear
David Bayles & Ted Orland
Image Continuum Press

Appendix T
A Brief Directory of On-Line Digital and Photography-Related Resources

The Internet has become a vast and prime source of free information about digital and film photography, and also a venue for the display of creative photo-related artwork. This appendix makes no attempt to be a comprehensive listing of sites that are available. The following are some of my personal bookmarks that I've found useful or interesting. Also remember that the Internet is a volatile place so some of the sites listed may have moved or been discontinued by the time you read this.

Note: **On some browsers you will need to enter "http://"before the listed Internet addresses.**

Some Digital Technical Reference Sites

studio.adobe.com/search/main.jsp
Adobe's Resource Center

www.adobe.com/digitalimag/ps_pro_primers.html
Adobe's White Papers and Tips on digital photography

johnpaulcaponigro.com/contents/index.html
A talented photographer whose site contains many useful links.

www.computer-darkroom.com/home.htm
Computer-Darkroom

www.dantestella.com/technical.html
Dante Stella
Some personal and satirical comments on technique

www.earthboundlight.com/phototip-archives.html
A great source of digital imaging tips and technical information.

www.shortcourses.com/how/histograms/histograms.htm
A short tutorial on histograms.

www.layersmagazine.com/design/ps-index.php
Layer Magazine's site for useful tips and ideas.

http://www.lightstalkers.org/
Lightstakers is a diverse and authoritative forum for photographers and other media workers.

www.luminous-landscape.com/
A great place to find clear tutorials on digital and film-based photography.

www.normankoren.com/light_color.html
A great place to find highly technical information regarding light and color.

photoshopnews.com/
A site for daily news about Photoshop and other digital photographic issues.

www.russellbrown.com/tips_tech.html
An original Adobe Photoshop genius offers great information and essential tools.

Other Useful Digital-related Sites

Cathy's Profiles
This is an excellent service that provides you with inexpensive custom profiles for color management.
www.cathysprofiles.com/

Chromix
Tools and software for all your color management needs.
www.chromix.com/

Digital Art Supplies
A comprehensive resource for digital printing supplies
www.digitalartsupplies.com/

Digital Photography Resources
www.shortcourses.com/

Digital Camera Reviews
www.dpreview.com/

Lexjet
One of the best sources of digital printing supplies and software.
www.lexjet.com/lexjet/

Photoshop Related Applications

Fixerlabs
This company offers high-quality applications for re-sizing and sharpening digital image files.
www.fixerlabs.com

Noise Ninja
My favorite noise reduction tool.
www.picturecode.com/

Pixel Genius
www.picturecode.com/
Sophisticated plug-ins for Photoshop sharpening and other effects.
www.pixelgenius.com/

Zone System-Related Sites

The Zone System
www.cicada.com/pub/photo/zs/

General Photography Sites

Black and White World
www.photogs.com/bwworld/

Digital Truth
A vast compilation of manufacturer recommended development times for every imaginable film.
www.digitaltruth.com/

The Photographer's Formulary
A great source of specialized photo chemistry and information.
www.photoformulary.com

Photo.Net
A site for general resources, essays, and equipment.
photo.net/photo/

Yahoo: Photography
The ultimate directory of online photography resources.
www.yahoo.com/Arts/Visual_Arts/Photography/

Some Virtual Galleries and Museums

After Image Gallery
One of the oldest fine art photo galleries in the country.
www.afterimagegallery.com/

The Ansel Adams Gallery
The web site of the famous gallery and bookstore in Yosemite Valley.
www.anseladams.com/

Aperture Gallery
http://www.aperture.org/

California Museum of Photography
www.cmp.ucr.edu/

Camera Obscura
Vintage and contemporary photography.
thor.he.net/~matheny/

Center for Creative Photography
A major museum and research center.
dizzy.library.arizona.edu/branches/ccp/ccphome.html

Center for Exploratory and Perceptual Art
http://cepagallery.com/

Center for Photographic Art
The site of one of the shrines of photography in Carmel, California.
www.photography.org/

The Center for Photography at Woodstock
A non-profit gallery and workshop organization for fine art photography.
www.cpw.org/

SF Camerawork
www.sfcamerawork.org/

Dom Fotografie/House of Photography
Fine Eastern European photography.
www.domfoto.sk/anglicka/newsletter/newsletter_e.htm

Equivalence: European Photography
equivalence.com/

The George Eastman House
www.eastman.org/

Fifty Crows
A site devoted to the support of photography for social change.
www.fiftycrows.org/about/

Charles Guice Fine Art Photography
Specializing in the artwork of black photographers.
www.charlesguice.com/

The History of Photography
www.rleggat.com/photohistory/index.html

Houston Center of Photography
http://www.hcponline.org/

The Image Works
An important editorial and commercial stock agency.
www.theimageworks.com/

The International Center of Photography
A major center of documentary and fine art photography.
www.icp.org/

The International Photo Gallery Project
www.markzane.com/

La Maison Europeenne de la Photographie
A center for European Photographic arts.
www.mep-fr.org/us/default_test_ok.htm

Museum of Photographic Arts
One of the most creative photo-institutions in the world.
www.mopa.org/

The Photographer's Gallery
www.photonet.org.uk/

The Photographic Resource Center
www.bu.edu/prc/

Photographs Do Not Bend Gallery in Dallas
www.photographsdonotbend.com/

The Southwest Museum of Photography At Daytona Beach Community College
www.smponline.org/

Documentary Photography Sites

Agence VU
www.agencevu.com/fr/visa2005/index.html

The Digital Journalist
digitaljournalist.org/

Magnum Photos
www.magnuminmotion.com/

Time Life Photo Sight
The best of the Time Life archives.
www.timelifepictures.com/ms_timepix/source/home/home.aspx?pg=1

War Shooter
warshooter.com/

VII Photo Agency
www.viiphoto.com/

Some Other Art-Related Photography Sites
Society of Photographic Educators
www.spenational.org/portfolio/index.html

LensWork Quarterly
Features a gallery, essays, and interviews.
www.lenswork.com/

The Light Factory
A site for innovative creative projects.
www.lightfactory.org/

The Manchester Craftsmen's Guild
William E. Strickland's center of art and community service.
www.manchesterguild.org/indexflash.htm

The Nearby Cafe
A gathering place for artists, creative projects, organizations and other cyber-cultural activities.
www.nearbycafe.com/

Urban Desires
A very sophisticated site of on-line cultural material.
www.desires.com/features/footprint/

The Visual Studies Workshop
www.vsw.org/

Zone Zero Gallery
A very sophisticated site featuring a gallery, a bookstore, and a forum.
www.zonezero.com/

Photo-Artist Sites

Christine Alicino
www.christinealicino.com/portfolio.php

Dan Burkholder
www.danburkholder.com/

Chris Johnson
www.chrisjohnsonphotographer.com

To Save a Life, Stories of Jewish Rescue
Ellen Landweber's labor of love.
www.humboldt.edu/~rescuers/

Mary Ellen Mark
www.maryellenmark.com/home/index.html

Jim Marshall Photography
Personal site of the legendary photographer of early rock music.
www.marshallphoto.com/

Susan Meisilas
A preeminent artist committed to creativity and justice
www.susanmeiselas.com/

Julio Mitchel
www.juliomitchel.com/

Eugene Richards
www.eugenerichards.com/

Sebastiao Salgado
One of the world's great documentary photographers.
www.terra.com.br/sebastiaosalgado/

Lonny Shavelson
www.photowords.com/

Elisabeth Sunday
www.elisabethsunday.com/

Virtual Magazines and Journals

Photo-Eye Books & Prints
An online photography bookstore.
www.photoeye.com/

Photography in New York
A bi-monthly guide to local, national, and international exhibitions.
www.photography-guide.com/

The Photo Review
A journal, gallery, and photography-related newsletter
www.photoreview.org/

Sight Photography
Online magazine of photography.
Sightphoto.com/photo.html

Appendix U
Examples: Zone System Applications

The idea for this appendix was inspired by my favorite Ansel Adams' book, Examples: The Making of 40 Photographs. In this classic, Ansel describes in great detail, and with thoughtful autobiographical comments, how he created many of his greatest images. His book allows one to begin to understand the complexities of his creative process and the role the Zone System played in making his photography masterful.

Contrary to some misconceptions, the Zone System is an extremely versatile tool with applications in many areas of photographic practice. This section demonstrates how you can apply the Zone System to color, architectural, digital, studio, figurative, and documentary photography.

Five participating photographers were asked to describe in their own words how the Zone System contributed to the creation of their images. These statements represent very personal approaches and illustrate how, with experience, the Zone System can be adapted to a wide range of photographic problems.

The common denominator in all these examples is previsualization. The ability to use the Zone Scale to form a mental image of your final print before taking the picture is a powerful creative advantage. Once the image is previsualized, the problem of how to achieve the desired result depends on the nature of the shooting circumstances and your materials.

My example of photographing with an automatic camera using color film is intentionally very far from the conventional approach, but it demonstrates the Zone System's flexibility.

I would like to thank Christine Alicino, David Bayles, Dan Burkholder, Judy Dater, Robert Bruce Langham III, and Julio Mitchel for their generosity and cooperation in preparing these examples.

Robert Bruce Langham III

I was exploring an old building not intending to photograph, when I found the attic three floors up. The space was tight. The light was harsh to non-existent. Illumination came from an overhead trap door. Wasps and spiders lurked in every shadow. I returned three times over the course of a month, bringing magnolia and yucca blooms from the overgrown lot below and finally Tri-X 5×7 pre-exposed to Zone II. The development times shrank to the minimum dared. Minus three. I boosted the shadows with reflectors.

The negative looked odd on the light table because of the pre-fog but prints on grade two with some dodging and burning, not much, and all in obvious places. On palladium paper from the Palladio Company in Cambridge it contacts directly.

This image was the end, though I didn't know it, of a ten-year period of photographic wandering. I was at the edge of getting untangled. It's part of a small but popular portfolio of architectural work not much shown. I feel like I came out of the dark, up the ladders, and climbed into the light.

Robert Bruce Langham III is a photographer and writer who lives and works very well, right where he was born in Tyler, East Texas.

CAMERA:	Deardorff 5×7, 90 mm lens
FILM:	Kodak Tri-X sheet film, rated at 160
EXPOSURE:	F/32 (or so) at several seconds
DEVELOPER:	Kodak HC-110 (B)
DEVELOPMENT:	Normal Minus 3
PRINT:	Contacted on palladium paper from the Palladio Co. Editions of 40

The Attic, Lewis Hotel, 1980.

David Bayles

This photograph was made with a view camera in the early 1970s, under the influence of reading John Cage and of wondering about randomness. I deliberately sought randomly organized objects as subjects — among them scatterings of driftwood imbedded in wind-smoothed sand (see Figure 14, p. 21) and jumbles of fallen flowers and leaves.

But by November, fallen leaves are drab. The negative was developed about N + 2; even so, there was a need for considerable burning of the darker values and some holding back of the lighter ones, all on fairly contrasty paper.

There is a kind of picture that glows even though the range of tones is quite compact, deep, and relatively soft. While such pictures may be hard to print, the tonalities aren't really hard to previsualize. The harder part is the anticipation of what — if anything — is the real content.

David Bayles studied photography with Ansel Adams and, together with Ted Orland, is the author of *Art and Fear: Observations On the Perils (and Rewards) of Artmaking*. David's work has been widely exhibited. He lives and works in Eugene, Oregon.

Untitled, 1970s.

Chris Johnson

June in Sévres was taken in a small town outside of Paris with an Olympus XA 35 mm camera using Kodacolor II film normally rated at ASA 100. I previsualized this as a rich, somber image with saturated color and June's back as a bright, pure form against the dark grass.

The XA is an aperture-preferred automatic camera, and its recommended exposure would have shown detail throughout the image. To bracket exposures with automatic cameras, it is necessary to bypass the meter's preference by changing the ASA setting according to the following rule: **Using a higher than normal ASA rating will decrease the exposure, while using a lower setting will increase it.**

In taking this picture, I first exposed one frame using the normal ASA and another at ASA 150. This in effect fooled the camera's built-in meter into placing its readings one-half zone lower than normal, resulting in the image shown.

Christine on Tomales Bay, 2005.

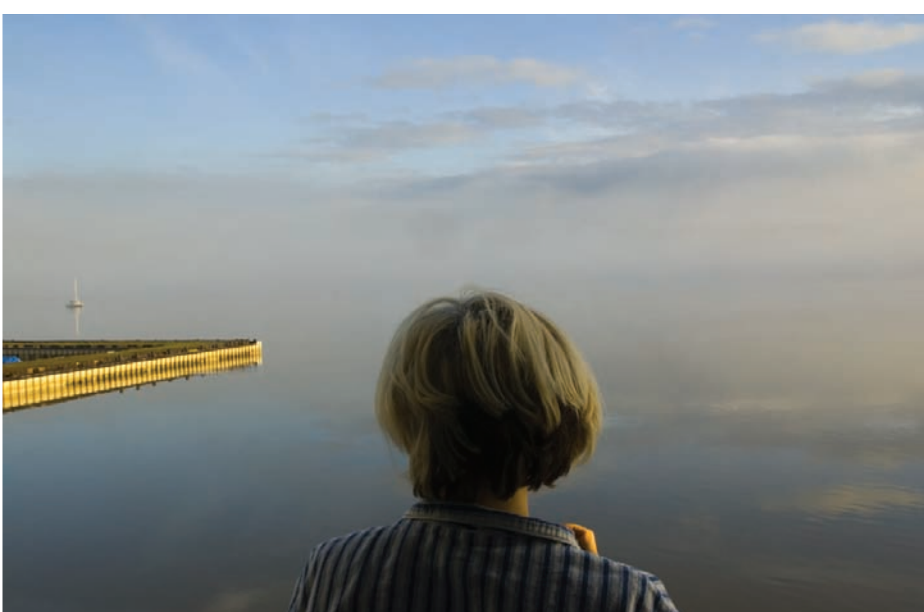
This moment presented itself to be photographed early one morning in Northern California. The camera I used was a Nikon D70 digital camera set to raw format at ISO 200.

To avoid digital noise in the subtle darker areas I biased the exposure toward the soft glow of the highlights as described in the section of Chapter 10 titled The Zone System of Digital Exposure: Exposing for the Highlights.

The initial tonal adjustments were done with Adobe's Camera Raw Utility. The file was sharpened with PhotoKit Capture Sharpener and the final color corrections were made with Photoshop's Levels command.

I printed this image on Hahnemuhle Photo Rag paper with an Epson 4000 inkjet printer.

June in Sévres, 1983.



Christine on Tomales Bay, 2005.

Dan Burkholder

Digital Zone System?

Looking over the way different people use the Zone System, I'm reminded of the fable of the blind men examining the elephant: The man feeling the elephant's leg says, "an elephant is like a tree," the one feeling the ear says, "an elephant is like a leaf"… and on it goes. The range of Zone System interpretations really isn't very different!

There was a time in my own image making when I used the Zone System more traditionally. That was way back when I used a view camera and spot meter to place my shadows and measure highlights to determine times for film development. Times have changed for me and the way I make photographs. For nearly seven years I've been shooting nothing but 35 mm and then scanning the negatives to work them over in Photoshop. I then generate an enlarged digital negative that I contact print on hand-coated platinum/palladium. What hasn't changed is the need to make tonal decisions!

Part of the learning curve problem with Photoshop is the new language it introduces to photographers. Instead of thinking Zone IV for dark gray with lots of detail and Zone VII for highlights on wet bricks, I've had to recalibrate my eye (and brain, a much more difficult task!) to look for 80% dot for the dark gray and 12% dot for the wet bricks. The thinking is the same; just the vocabulary has changed. The important thing is that it was my traditional grooming within the Zone System that bred a discipline for tonal examination and good image decision making. And (both sadly and reassuringly) when the final print doesn't turn out like I'd hoped, it's usually because of bad judgment calls on my part, not because I need a better meter, a more sensitive densitometer … or faster computer!

Now let's see (says Dan, closing his eyes and feeling his computer monitor) … this digital imaging stuff is just like an expensive television that crashes!

Dan Burkholder's platinum prints have been exhibited and published internationally. The second edition of his award-winning book *Making Digital Negatives for Contact Printing* was published in 1999 and is currently in it's second edition (www.danburkholder.com).

Rodential Resurrection, 1998.

Christine Alicino

This portrait was done for Rolf Engle's 60th birthday so I was looking for an image of him that was stately, sensitive, and conveyed his dignity and creativity.

What I love about working with lights in the studio is that I can control the technical aspects of the process so that I can concentrate on the mood and presence of the subject.

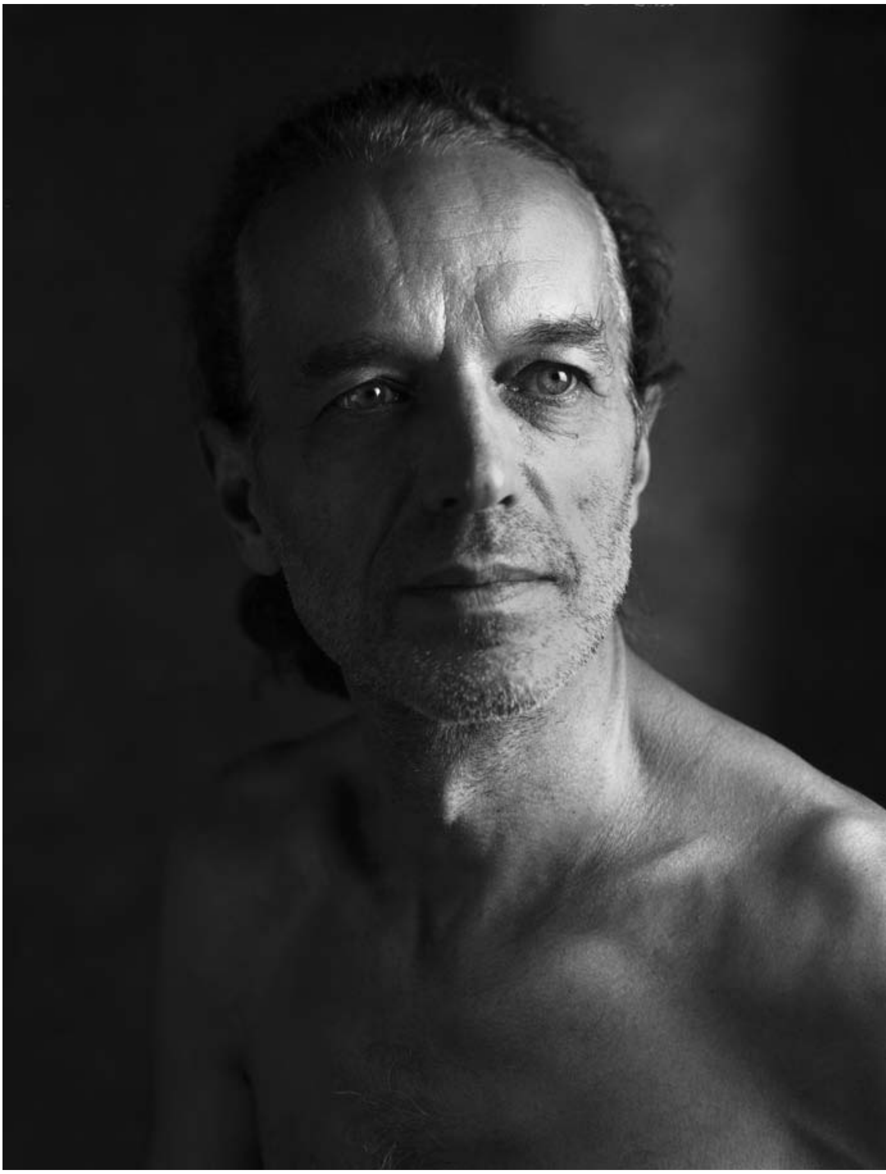
This was especially important in this case because I was using Polaroid Type 55 film, which meant that the exposure and contrast needed to be perfect since there was no opportunity to change things after the fact.

I previsualized this portrait as having soft but dramatic contrast. The background needed to be dark but light enough to allow for separation with his hair (Zones III and IV). His skin needed to be luminous but detailed (Zones VI and VII).

Since the light source was a continuous, daylight balanced light with a fresnel lens in a soft box, I used the distance between the subject and the background to control the shadow values and between the subject and the light source to control the highlights. I used an incident light meter to determine the exposure.

Christine Alicino is a freelance professional and fine art photographer who shoots people, products, editorial, and environmental photography in the San Francisco Bay Area (www.christinealicino.com).

LIGHT SOURCE: 1000 watt HMI in a soft box
FILM: Polaroid Type 55
ASA: 50
DEVELOPER: N/A
DEVELOPMENT: Normal



Rolf Engle, 2002.

Judy Dater

This untitled photograph was taken very late in the afternoon after the sun had set. I was attracted to the strange and inexplicable white boulder sitting on the dark red-brown earth. I wanted to heighten the contrast of the white rock, rope, and figure against the dark ground. I metered the earth and placed it on Zone III. Then I metered the rock and found that I would have to develop the film at N + 2 to bring it up to Zone VII. This produced the desired effect.

Judy Dater is one of the best known fine-arts photographers in the world. Her work has appeared in major museum exhibitions and photography publications, and she has been awarded the Dorothea Lange Award of the Oakland Museum and the Guggenheim Award for her outstanding contributions to photography. She is the author of *Women and Other Visions* with Jack Welpott, and *Imogen Cunningham: A Portrait and Cycles* published in 1994.

FILM: Kodak Tri-X, 4 × 5
ASA: 200
DEVELOPER: Kodak HC-110, Dilution B
DEVELOPMENT TIME: 10 minutes

Untitled, 1983.

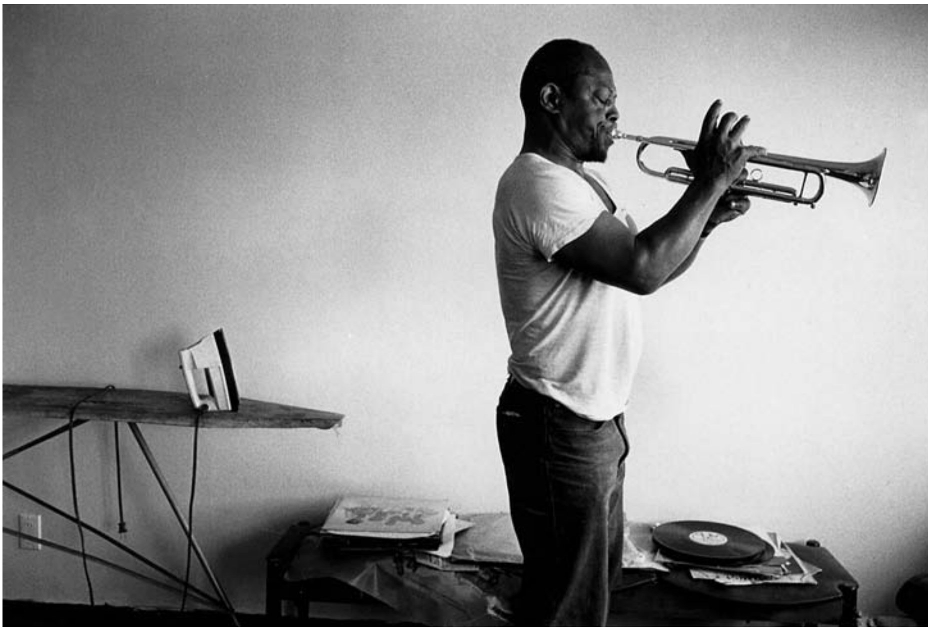
Julio Mitchel

I begin by setting my meter to an ASA that gives me one stop more exposure than the manufacturer's indicated speed, (they usually exaggerate). Then I take a reflected reading as close as possible without disturbing the subject in the area of the darkest tone where I want the minimum amount of detail. Back in the darkroom I develop for the highlights. Generally this means 20% less development under normal contrast lighting conditions. If the lighting is completely flat I then leave my reading at the manufacturer's given ASA and then I develop at the "normal" processing time. My photograph of jazz trumpeter Jimmy Robinson was made this way.

Given the fact that in the real world, life is not perfect, considering the subject matter that I deal with, and, not having the luxury of landscape or studio photographers, I sometimes have to tailor my technique. In situations where the contrast is extreme, I wait for the most important part of my subject to face the highlights and I expose for that, letting the shadows go black. That's how the image of the musicians and children in Ecuador was done. All of this assumes that I intend to print with a coldlight enlarger.

Julio Mitchel is one of the world's great documentary photographers. He has produced major bodies of work (most of these unpublished) on such diverse subjects as the exploitation of juvenile boxers, the troubles in Northern Ireland, the influences of military and political power on the peoples of Latin America, the dynamics of love, the creative lives of jazz musicians, and the Statue of Liberty as a metaphor for the ironies of freedom in America.

The two books on his work are *Triptych*, 1990 and *Do You Love Me*, 1991. He is the recipient of numerous grants and awards and his work has been exhibited throughout the world http://www.juliomitchel.com/.



Jimmy Robinson at Home.

Ecuador, from "South of the Border."

A Primer on

Basic Film Photography

This section is designed for students who need a brief review of basic photography to better understand some of the terms and concepts used throughout this book. In general, this chapter is a summary of those principles and techniques that relate to film exposure and development. Because the primer is intended to serve only as an aid to learning the Zone System, many important subjects aren't covered in detail. For a more comprehensive text on basic photography, I recommend the following books:

1. *Photography,* London and Upton, Prentice Hall
2. *Basic Photography*, M. J. Langford, Focal Press
3. *The* Ansel Adams Photography Series, Bulfinch Press

Unfortunately, photography is notorious for being complicated and difficult to learn. In the beginning, it is easy to get lost in the maze of photography's many inverse relationships. At every step it seems as if something light is turning something dark, which in turn causes something else to become light again. Confusion is understandable, but photographic processes are easier to comprehend if you keep in mind that you'll have to deal with a limited number of very simple materials that consistently perform very simple functions.

Photographic Emulsions

The essential component of photography is a light-sensitive coating called an **emulsion.** When this emulsion is spread on one side of a piece of transparent material, we call it **film.** When an emulsion is applied to a piece of paper, it is used to make **photographic prints.** Film and prints may appear to be very different, but their emulsions are essentially the same.

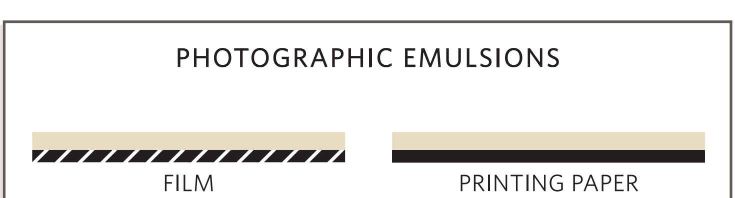


FIGURE 158 Film and paper emulsions.

All photographic emulsions respond to light in a simple way: Wherever the emulsion is exposed to light, a fine layer of metallic silver will be formed after development. The greater the amount of exposure, the more dense the deposit of silver will be.

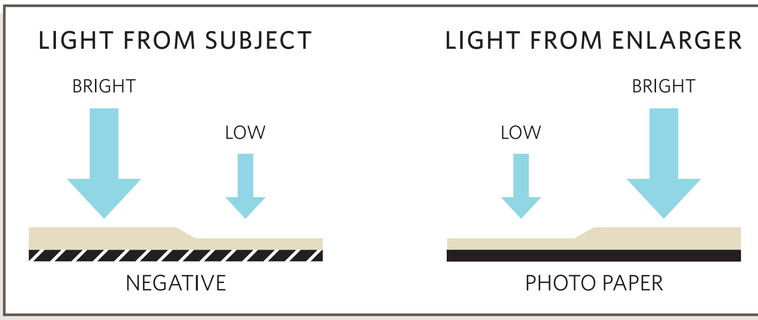


FIGURE 159 Film and paper densities.

The Negative

On the film, these densities of silver are seen as the shadow-like reversed images we call the **negative.** The negative image is tonally reversed because any area of the scene that is bright will produce a dark layer of silver on the film. Conversely, a darker area of the scene will result in a relatively thin or transparent area on the film. See Figure 159A.

The Print

The photographic printing process reverses the light-to-dark effect of the negative. The enlarger projects the shadow of the negative onto the emulsion of the paper. Once again, the light that passes through the transparent parts of the negative (corresponding to the darker parts of the subject) produce dark layers of silver on the white paper after development. The more transparent a given area of the negative, the more light it will transmit to expose the paper and the darker that area of the print will become. The areas of the negative that are more dense (corresponding to the lighter areas of the scene) block more light. As a result, those areas of the print remain light. In this way, the lifelike image of the print will be produced.

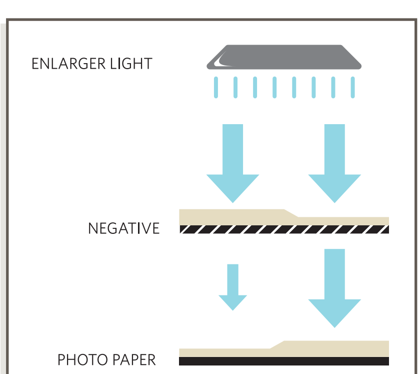


FIGURE 160 Enlarger, negative, and print.

The overall tonality of a print can be made lighter or darker by increasing or decreasing the amount of light that exposes the paper. Selected areas of the print can be darkened by adding more light to those areas. This is called **burning in.** If you want to make a certain part of the print lighter, all you have to do is hold back the light in that area with your hand or a tool. This is called **dodging.**

To distinguish between the light and dark areas of the subject and the light and dark areas of the print, subject brightnesses are called **subject values.** The gray, black, and white areas of the print are called **print values**, or **tones.**

Let's summarize what we have learned about emulsions, negatives, and prints:

1. The photographic emulsions of the films and prints are essentially the same. When an emulsion is exposed to light, it produces a density of silver after being developed. The greater the exposure, the greater the density.
2. A light value in the subject produces a high density in the negative, which results in a light tone in the print.
3. A dark value in the subject produces a low density in the negative, which results in a dark tone in the print.

Memorize these three principles before you go on.

Processing

After a photographic emulsion has been exposed, it must be processed for the image to appear and remain stable. Processing means putting the emulsion through a series of chemical baths called developer, stop bath, and fixer. The chemistry and procedures are essentially the same for processing film and paper. The main difference is that film processing must be done in complete darkness to prevent the film from becoming fogged. Print processing can be done under a red-filtered light called a safelight. You should read the instructions supplied with all chemicals before using them.

Step 1 – Developer

Before an exposed emulsion has been processed, there is no noticeable change in its appearance. At this point, the negative is said to contain a "latent image." The developer chemically converts this latent image to the visible silver image that makes up the negative and print. Remember that **the longer the emulsion is left in the developer, the more dense these deposits of silver will be.** If film is left in the developer for too long, these deposits of silver will become so dense that they will block too much of the light from the enlarger, and the print will be too white and contrasty. This effect is called overdevelopment. If a negative is underdeveloped, areas of the print that should be white will instead be gray, and the print will be dark and muddy. Prints that are under- or overdeveloped will either be too light or too dark, respectively. For this reason, the development stage of the process must be timed carefully. As you will learn from this book, the correct development time for film depends on the contrast of the subject. The standard development time for most photographic paper is from two to four minutes. For more information on developers, refer to Appendices E, G, and J.

Step 2 – Stop Bath

Because the timing of the development stage of the process is so critical, it is important that the emulsion stop developing as soon as the proper density has been reached. Developers must be alkaline to work. Because stop baths are acidic, immersing films or papers in a stop-bath solution will stop the developing process immediately. A 15- to 30-second rinse in fresh stop bath is sufficient.

Step 3 – Fixer (Hypo)

The fixing bath dissolves the remaining unexposed silver in the emulsion and allows it to be washed away. It is important that the fixing stage of the process be complete because any residues of unexposed silver will eventually stain the film or print and ruin the image. If your fixer is fresh and properly diluted, the minimum time that you should fix your negatives and prints before turning on the white light is two minutes for negatives and one minute for prints. Certain rapid fixers reduce the time required for complete fixing. Be sure that you read the manufacturer's instructions very carefully for proper dilutions and times.

Step 4 – Washing

After your negatives or prints have been processed, they must be thoroughly washed in clean water to remove any traces of fixer from the emulsion. The use of a hypo clearing agent will greatly reduce the amount of washing time necessary to do a good job. Once again, carefully follow the manufacturer's instructions. Improperly washed negatives and prints will become stained.

Step 5 – Drying

Many photographers take drying for granted, but it's easy to ruin a good negative or print at this point. A wet emulsion is very soft and can be scratched or attract dust if you aren't careful.

Even more serious are the uneven densities that can form in negatives because of drops of water drying on the surface of your film. To avoid this you should always use a wetting agent in your final rinse to prevent spotting. This isn't necessary when drying prints. Be sure to dry your negatives and prints in a clean, dust-free area.

Efficient processing is essential for getting good results in your photography. There is nothing more frustrating than spoiling a good negative by being sloppy or careless. Particular attention should be paid to the following points:

1. **Cleanliness.** Many unnecessary negative and print defects are caused by not washing your hands, tanks, trays, and reels carefully. Traces of fixer or developer on your fingers can easily leave stains on your prints that can't be removed. Keep in mind that even a soiled towel or a contaminated light switch can transfer chemicals to your hands if you aren't careful. The first time you discover a thumbprint etched into your favorite negative, you will appreciate the importance of being careful and clean.

2. **Agitation.** Agitation means causing your photo-chemistry to circulate and flow around the film or paper by keeping the development tank or printing tray in motion for a given amount of time during each stage of the process. This is necessary for the development and fixing of the emulsion to be even and complete. Film agitation is usually done by inverting and rotating the tank in a continuous and rhythmic twisting motion. The proper film agitation motion is infinitely easier to demonstrate than describe. One manual recommends that you use a "quasi-spiral torus motion." I would suggest that you find a friendly camera salesperson or photographer and ask him or her to show you how it's done. You might want to check the salesperson's negatives and prints to see whether he has trouble with development streaks or air bubbles.

   Correct agitation is especially important during the development stage of the process. If the motion you use fails to circulate the developer evenly around your film, your negative will have areas of uneven density that will show in your prints. Jerky or consistently violent agitation movements can create bubbles in the developer that can stick to your film and cause spots. To dislodge any of these bubbles, you should rap your tank against a hard surface after each agitation. Perhaps the most important thing to remember about agitation is that **the longer and more aggressively you agitate, the faster your film will develop.** For this reason, it is important that you establish a definite plan for your agitation and follow it religiously. This is especially important during the development and fixing stages of the process. A typical agitation plan would be:
   - For developments from 3 to 4 minutes — Agitate continuously.
   - For developments from 4 to 15 minutes — Agitate for 30 seconds, rest for 30 seconds, then agitate for 5 seconds of every 30 seconds thereafter.
   - For developments longer than 15 minutes — Agitate continuously for 1 minute, rest for the next minute, then agitate for 30 seconds of every 2 minutes thereafter.
3. **Temperature.** It is very important that you adjust the temperature of the processing solutions before you begin using them. The cooler photo-chemicals become, the less efficient they are. Conversely, the warmer your chemicals are, the faster they will work. Most photo-chemicals are formulated to work at 68 degrees. If for some reason you have to use your chemistry at a higher or lower temperature, consult a time and temperature conversion chart for the correct development time at a given temperature. These are usually provided with your developer.

   It is also very important that the temperature of all your chemicals is the same. This includes the water you use to wash your negatives and prints. A more than 1- or 2-degree variation in the temperature of your chemicals can seriously damage the quality of your negatives.
4. **Dilution.** Carefully follow the manufacturer's mixing instructions for all your photo-chemistry. Inconsistent dilution of your chemistry will make it impossible for you to control or standardize your processing results. Developer or fixing solutions that are either too dilute or too concentrated will drastically affect the amount of time it takes to produce the best results. The rule is: **The more concentrated the developer and fixer, the faster they will work.** Of course, the reverse is also true. The more

dilute the photo-chemistry, the longer your processing time will be. For more information about dilutions, refer to Appendix J.

As you can see, agitation, temperature, and dilution are processing variables that must be carefully controlled to give your photographic work the consistency you need. When you become more experienced, you will discover that there are advantages to modifying all these controls, but in the initial stages, it's a good idea to consider development time the only variable that you can reliably control.

Film Processing

Step 1:	Development	3 to 30 minutes
Step 2:	Stop bath	30 seconds
Step 3:	Fixer	5 minutes (check instructions)
Step 4:	Rinse	2 minutes
Step 5:	Hypo clear	3 minutes
Step 6:	Final wash	15 minutes
Step 7:	Wetting agent	1 minute
Step 8:	Dry	

Note: The exact development times for film will vary greatly according to a number of factors, including the film you are using, the developer and dilution, and most important, the contrast of the scene being photographed. This subject is covered thoroughly in Chapter 6.

Print Processing

Step 1:	Development	2 to 4 minutes
Step 2:	Stop bath	30 seconds
Step 3:	Fixer	5 minutes
Step 4:	Wash	2 minutes
Step 5:	Hypo clear	2 minutes
Step 6:	Final wash	1 hour (archival)
Step 7:	Dry	

ASA

By altering the size and composition of the silver grains in the emulsion, films can be made more or less sensitive to light. The more sensitive an emulsion is, the less light it takes to produce a given density. Very sensitive films are said to be faster than films that are less sensitive because they allow you to use a faster shutter speed in a given lighting situation. Films of various speeds

are assigned numbers by the American Standards Association. These are called ASA numbers. The important thing to remember about ASA numbers is that **the higher the film's ASA number, the faster the film.** Thus a film rated ASA 400 is more sensitive to light than a film rated ASA 125. Faster films tend to be more grainy than slower films, but they're an advantage when you're shooting in low-light situations.

You will learn much more about ASA and its effect on exposure and development in the main body of this book, but the essential concept is as simple as that. See Appendix N.

Paper Grades

Photographic printing papers are available in a wide variety of textures, thicknesses, and tonalities. **Resin-coated** (RC) papers require much less washing and dry more quickly than **fiber-based papers.** Fiber-based papers are generally preferred for exhibition-quality printing because they are more archival. There are a number of excellent, exhibition-quality papers currently on the market. These include Ilford Galerie, Ilford Multigrade, and Bergger Prestige Fine Art Supreme. Single-weight papers are less expensive but are more vulnerable to creasing than double-weight papers. "Warm-tone" papers print with a brownish or sepia tone, while normal or "cold-tone" papers are more neutral. To become familiar with the variety of papers available, compare the paper sample books displayed at many photo supply stores.

One fundamental characteristic of a photographic paper is its **contrast.** Figures 161A and B illustrate the difference in contrast between two papers of different "grades" used to print the same negative.

(A)
Paper grade 2

(B)
Paper grade 4

FIGURE 161 Photographic paper contrast examples.

Figure 161A is "softer" or "flatter" than 161B and has more gradual transitions from one tonal value to another. Figure 161B has greater separation between print tones that are relatively close in value. This is especially visible in the background and in the child's face. **Tonal range** and **tonal separation** are two ways of defining the contrast of a photographic print. While

the tonal range of different prints may be the same, meaning that the blacks are just as black and the whites as white, higher-contrast papers separate close tones more sharply. If your film is properly exposed and developed, the choice of what grade of paper to use for a negative depends on your sense of how that negative should be interpreted.

Photographic printing papers are assigned numbers according to the contrast a particular paper will make from a given negative. The rule is: **The higher the number, the more contrast the paper will have.** These numbers run from 0 for the very low contrast papers to 5 for extremely high contrast papers. Photographic papers are available in two forms, **graded papers** and **variable-contrast** or **polycontrast papers.**

With graded papers, you have to buy a separate supply of paper for every contrast you want. Graded papers are available in a wide range of contrast grades and generally have superior tonal quality.

Variable-contrast papers allow you to change the contrast of each sheet by using a set of numbered filters. Each filter in the set represents a different contrast grade according to its number. The higher the filter's number, the higher the contrast. For obvious reasons, variable-contrast papers tend to be more economical. With practice, it's also possible to use two or even three different filters on the same sheet of variable-contrast paper. You can, for example, use a low-contrast filter (number 1 or 2) to print the sky of a given negative and a high-contrast filter 2 (number 3 or 4) for the foreground. Variable-contrast papers also have the advantage of allowing you to change the contrast by one-half-grade steps.

Different brands of paper of the same grade will often have different contrasts. This is due to the difference in manufacturing standards and specifications. It's a good idea to become familiar with the characteristics of one brand of paper before trying another.

A **normal** grade of paper (usually grade or filter 2) is one that will make the best print from a negative that has *Normal contrast*. If the negative you are printing has *less* than Normal contrast, you will tend to use a *higher* grade of paper. If your negative has *too much* contrast, you will want to use a *lower* than normal grade of paper. The problem with this random method of printing is that the farther you get from normal-contrast negatives and papers, the more difficult it becomes to control the subtle nuances of tone that make fine prints so beautiful. Ideally, if all your negatives printed well on normal grades of paper, you would be free to use the higher or lower grades for interpreting your images in other, perhaps more creative, ways. Each grade of paper has a unique quality. The secret of fine printing is to discover which grade is best suited to the quality of print you are trying to make, then *adapt the contrast of your negatives to fit that particular grade.* The Zone System is specifically designed to make this possible.

The contrast of a given grade of print is also affected by the paper developer you choose to use. Kodak Dektol is a standard print developer that produces normal-contrast prints when used at dilutions of 1:2 or 1:3. Kodak Selectol-Soft is a slower, "softer-working" developer that will give you less contrast than Dektol on the same grade of paper.

The Camera

Essentially, any camera is simply a device that uses a lens to focus the light reflected by an object onto a piece of photographic film. It's very important to understand and remember that only a

certain amount of this reflected light must be allowed to expose the film. When this is done properly, we say that the film has been given the correct exposure.

The Aperture

The camera has two mechanisms that control the amount of light that's allowed to expose the film. The first is called the *diaphragm*. The diaphragm is simply a metal membrane in front of the film with an adjustable hole in it called the *aperture.* **The larger the aperture, the more light it will let into the camera to expose the film.**

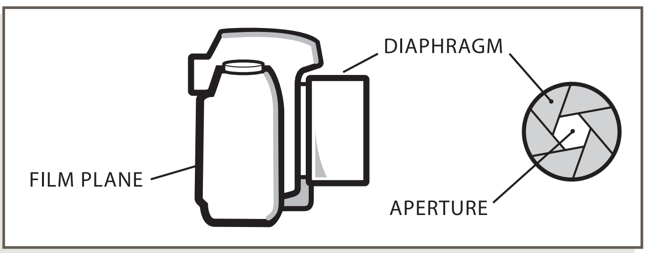


FIGURE 162 Camera and diaphragm.

The various aperture sizes are measured with numbers called **f/stops**. Typical f/stop numbers are f/1.4, f/2, f/2.8, f/4, f/5.6, and f/8. You must remember two rules relating to f/stops:

1. The larger the f/stop number, the smaller the opening of the aperture. Thus, f/8 represents a smaller aperture (and less exposure) than f/5.6. A simple way to remember this is to consider f/numbers as you would ordinary fractions: 1/16 of a pie is smaller than 1/2 of a pie.
2. The second rule relates to what is called **depth of field.**

When you focus a camera on a given object, any object that is equally distant from the camera will also be in focus. This distance is called the **plane of sharp focus** (Figure 163).

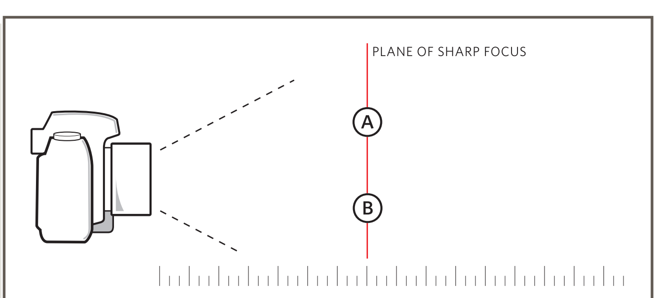


FIGURE 163 Objects A and B are in focus.

Any object that is within a certain distance in front of or behind this plane will also appear to be in focus. This range of distance within which objects appear to be in focus is called the depth of field. The farther an object is from this depth of field, the more out of focus it will be.

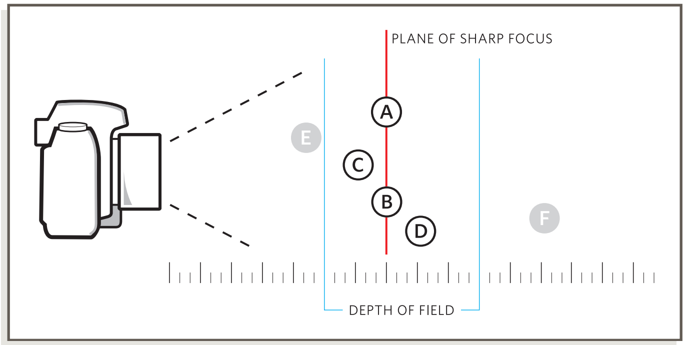


FIGURE 164 Objects C and D are in focus. Objects E and F are out of focus.

The amount of depth of field depends on the size of the aperture. **The smaller the aperture, the greater the depth of field.** Thus, f/8 will give you more depth of field than f/5.6.

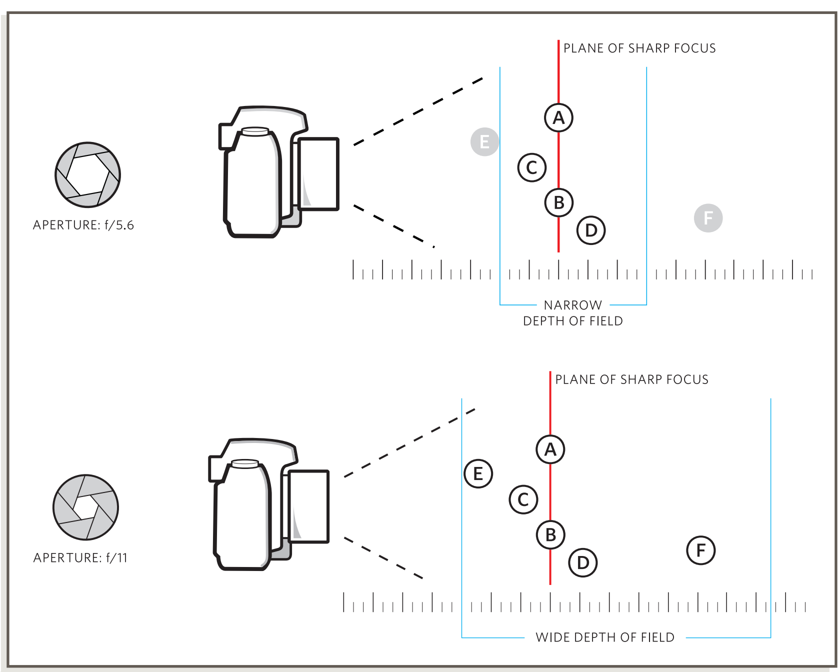


FIGURE 165 Depth of field increases from f/5.6 to f/8.

This is important to know because there are times when you will want as much depth of field as possible and others when you will want to use a selective focus to isolate objects in a given scene.

The Shutter

The second mechanism that the camera uses to control the amount of light that exposes the film is called the **shutter.** The shutter is a device that determines **how long** the film is exposed to the light that passes through the aperture. **The longer the shutter is open, the greater the exposure.** The shutter is controlled by setting the shutter speed dial. Typical shutter speeds are 1/60, 1/30, 1/15, and 1/8. These numbers represent fractions of a second. Therefore, 1/60 of a second is less time than 1/30 of a second and is said to be a faster shutter speed. Shutter speeds faster than 1/60 are useful for making objects that are moving appear sharp, and also for helping prevent camera motion from blurring the image. As a rule, you should try to avoid using shutter speeds slower than 1/30 of a second when you are shooting without a tripod.

Exposure

By using the correct combination of f/stop and shutter speed, you can give the film the proper exposure for any photographic subject. See Chapter 5 for more information on this subject.

The correct exposure for a given picture is determined by using a **light meter.** A light meter performs two basic functions. The first is to measure the amount of light that is falling on the subject (this is called incident light) or the light that is reflected by the subject. The function and uses of various types of light meters are discussed in Chapter 5. For our purposes, the hand-held reflected-light meter is the most useful.

The first step for determining your exposure is to set the meter's ASA dial to the ASA of the film you are using. Carefully read the owner's manual that came with your meter to see how this is done. Next, it's very important that you carefully aim the meter at the subject you are photographing. Ideally the meter should "see" exactly what the film will see when the picture is taken. When the meter is activated, an arrow or needle of some kind will swing to the meter number that represents a measurement of the amount of light reflected by the subject. The important thing to remember about light meters is that **the higher the number, the greater the amount of light being measured.**

The next step is to use the meter's exposure dial to determine the correct exposure. This is done by turning the movable wheel on the dial until the meter's indicating arrow is matched against

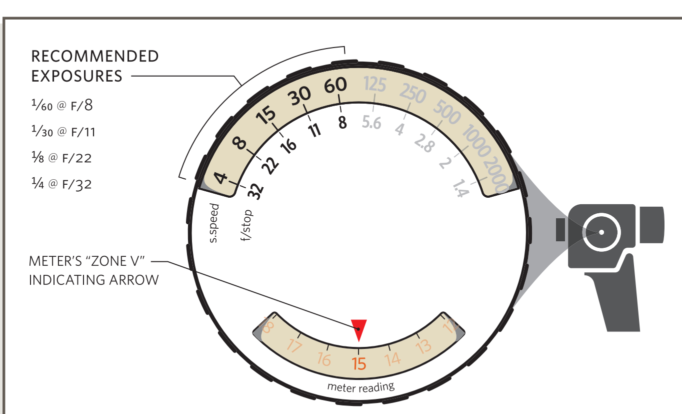


FIGURE 166 A hand-held light meter and its recommended exposures.

the number chosen by the meter. At this point, you will see that the meter is recommending a wide range of f/stop and shutter combinations for you to use.

In this example, any of these combinations of f/stop and shutter speed will give you the same exposure. This is true because any given f/stop and **any given shutter speed both allow the same amount of light to enter the camera.** (The one exception to this rule is explained in Appendix O in the section Reciprocity Effect.)

If the meter recommends an exposure of f/11 at 1/30 of a second, f/16 at 1/15 of a second will let the same amount of light into the camera. This may sound confusing, but it will make sense if you think about it for a moment. F/16 is one-half the aperture size of f/11, but 1/15 of a second allows f/11 to stay open for twice as long. This means that the combination of f/stop and shutter speed that you choose should be based on whether depth of field or stopping motion is more important to the picture you want to take. If you want an exposure with greater depth of field, you will choose a combination with a smaller aperture (in other words, a higher f/stop number). If you are photographing moving objects, you should choose an exposure with a faster shutter speed.

Hand-Held Light Meters

Let's summarize the general steps for determining an exposure with a hand-held reflected-light meter:

1. Set the film's ASA into the meter.
2. Carefully aim your meter at the scene.
3. Turn the meter's indicating arrow until it matches the number chosen by the meter for that lighting situation.
4. Select a combination of f/stop and shutter speed to use for setting the camera according to the following rules:
   a. If you want great depth of field, choose an exposure with a small aperture (a high f/stop number).
   b. If you are shooting moving objects or hand-holding the camera, choose an exposure with a fast shutter speed.
5. Set your camera to the exposure you have chosen and shoot the picture.

In-Camera Light Meters

In-camera meters base their exposures on the light that enters through the lens of the camera. This is an advantage in many ways, but a disadvantage in others. Because the meter is measuring the same image you see through the viewfinder, it's very easy to aim the meter properly to include exactly what you want it to see. Built-in meters are also very light, and when combined with modern automatic cameras, they are easy to use.

There are many different types of in-camera meters. For this reason, it's very important that you know which features will best suit your needs before you buy a particular camera. See page 74 for a more detailed discussion on this subject.

Fully Automatic Cameras

This type of camera automatically chooses a combination of f/stop and shutter speed to expose a given scene. Often there is no way for the photographer to know what the actual exposure is.

Although easy to use, this makes it impossible for you to exercise any creative control over the photographic process.

Semi-Automatic Cameras

There are two general types of semi-automatic cameras — aperture preferred and shutter preferred. Cameras with aperture priority allow you to choose the f/stop you prefer for a given scene while the meter chooses the shutter speed. Usually the shutter speed is displayed in the view finder so that you can determine whether it is fast enough to stop any motion that may be in your picture. Shutter-priority meters automatically select an aperture for every shutter speed you choose.

One general problem with both and fully semi-automatic cameras is that whichever method the meter uses, you're still locked into using the exposure chosen by the camera. In many cases, this exposure will be adequate, but it prevents you from being able to adapt the exposure to suit your own interpretations. In general, as you become more involved with the process of taking better photographs, you will find that any system that limits your choices will be less desirable.

Needless to say, there is a great deal to be said about the process of exposing your film correctly. At this point, you are ready to begin Chapter 1. of this book.

A Brief Glossary of

Zone System and Digital Terminology

Acutance — The term used to describe the degree to which a negative renders a sharp distinction between adjacent print tones. Acutance is related to negative contrast and shouldn't be confused with image sharpness or resolution. Dilute developers and long development times will increase acutance.

Banding — In a digital image, banding appears as distinct tonal steps where there should be a smooth continuous gradation. This is generally considered to be a problem that is caused by the loss of pixel levels when the image is edited in one of Adobe Photoshop's contrast adjustment tools like the Levels or Curves command. Posterization is another word commonly used to describe this effect.

Bit Depth — A pixel's bit depth is a measure of the number of individual tones of gray or color a pixel is allowed to be in an image, measured in bits of digital memory.

Bitmapped — A bitmapped digital image is one composed of numerous individual tile-like picture elements known as pixels. Bitmapped images are said to be rasterized as opposed to vector-based images that are constructed from mathematically defined shapes and lines.

Bracketing — After using a light meter to determine the "correct" f/stop and shutter speed for a given photograph, you would use bracketing to give the film more or less than this base exposure to achieve the desired result. Bracketing is usually done by adjusting the aperture.

Charge Coupled Device (CCD) — One of the two main types of image sensors used in digital cameras.

Clipping — In digital photography, a light or dark tonal value is said to be clipped when a Photoshop contrast adjustment pushes that value beyond the range of tones that can be rendered.

CMOS (Complementary Metal-Oxide Semiconductor) — One of the two main types of image sensors used in digital cameras.

Color Management — The calibration, profiling, and coordination of all elements in a digital imaging workflow for the purpose of insuring that the final print or other output matches the image represented on the computer monitor as closely as possible.

Colorsync — A color management system introduced by Apple Computer Co.

Contraction — The decrease in negative contrast brought about by using a development time that is less than Normal Development. Contraction is symbolized by N-, followed by the number of zones by which you want to decrease the contrast. For example, N − 2 means decrease the development time below Normal Development enough to reduce a Zone IX negative density to a density equivalent to Zone VII. Contraction is also known as "compaction."

Contrast

1. Subject contrast refers to the relative difference between the amount of light reflected by the "highlights," or bright areas, of the subject and the "shadows," or darker areas. This difference is measured with a reflected-light meter.
2. Negative contrast refers to the relative difference between the "shadow," or thinner, areas of the negative and the "highlight," or more dense, areas.
3. Print contrast (also called tonal separation) is the ability of the film and printing paper to render a visual distinction between close tonal values. Print contrast increases when a negative is printed on higher grades of paper.

Density — Density is technically a scientific term used to indicate the relative opacity of a negative as measured with a densitometer. The term is commonly understood to mean the relative thickness of silver in the negative.

DPI (Dots per inch) — A measurement of the resolution of a digital photo or digital device, including digital cameras and printers. The higher the number, the greater the resolution.

Drivers — Software associated with digital scanners and printers that controls the functioning and coordination of the device with all other elements of the workflow.

Dynamic Range — The term used to define the total range of tonal values in a digital image. Also referred to as contrast.

Expansion — The increase in negative density brought about by developing the negative longer than Normal Development. Expansions are symbolized by N+, followed by the number of zones by which you want to increase the contrast. For example, N + 2 means to increase the negative's development time above Normal Development enough to raise a Zone VI negative density to a Zone VIII density.

Fall — The term used to indicate the position of any subject's meter reading on the Zone Scale after another meter reading has been placed on a different zone. For example, when the contrast of the subject is Normal, the meter reading for the highlight will fall on Zone VII when the meter reading for the shadow is placed on Zone III.

Gamut — The total range of colors that a digital device can reproduce.

Histogram — A graphic representation of the range of tones from dark to light in a digital photograph.

Important Highlight — The area of the subject that you want to appear in the final print as a fully textured and detailed light gray tone. In most cases, this area will be previsualized as Zone VII. Light clothing, concrete, and fully textured white objects are typical Important Highlight Area subjects.

Important Shadow — The area of the scene that you want to appear in the final print as a fully detailed dark value. This need not be an actual shadow. In most cases, the Important Shadow Area is previsualized as Zone III. Dark clothing, brown hair, and green foliage are common Important Shadow Area subjects.

Incident Light — The light that falls on the subject from the light source; measured with an incident-light meter.

Indicating Arrow — The arrow or pointer on a hand-held light meter that is matched with the indicated meter reading to calculate the meter's recommended exposure. The meter number indicated by this arrow is automatically placed on Zone V.

Interpolation — A mathematical method of creating missing image data to increase the file size and/or dimensions of an image.

JPEG — A standard for compressing image data developed by the Joint Photographic Experts Group.

LCD (Liquid Crystal Display) — A low-power monitor often used on the top and/or rear of a digital camera to display settings or the photo itself.

Megabyte (MB) — A measurement of data storage equal to 1024 kilobytes (KB).

Megapixel — Equal to one million pixels.

Neutral Gray Card — A middle gray (18 percent) card designed for calibrating exposure meters and to serve as a visual reference for color reproduction. Also known as a Zone V card.

Noise — Random patterns of either color or brightness that appear in the shadow areas of digital images when higher ISO settings (400 and above).

Normal

a. Subject contrast is said to be Normal when the meter readings of the Important Shadow and the Important Highlight fall on Zone III and Zone VII, respectively.

b. Negative contrast is considered Normal when the negative prints well on a Normal grade of paper, usually paper grade 2 or variable-contrast filter 2.

c. Normal Development is the amount of development for a given film and developer that will produce contrast in the negative that is equal to the contrast of the subject. Normal Development is symbolized by N.

Pixel — Pixels or picture elements are the smallest components of digital images. Digital camera and monitor pixels are the physical units that capture and display digital image data, respectively. Image pixels are the individual "tiles" of color or tone that make up the visible image on a monitor.

Placement — The act of relating any single meter reading to a zone on the Zone Scale through controlled exposure. For example, to place a shadow reading on Zone III, you first meter that area with a reflected-light meter, then stop down two stops from the meter's recommended exposure.

Posterization — See Banding.

Previsualization (also *visualization*) — The act of mentally picturing a photographic subject in terms of the finished print.

Profiles — A small data file that describes the color idiosyncrasies of each element of a color-managed digital workflow including the monitor and printer for the purpose of providing coordination of color rendition from one end of the process to the other.

Raster Image Processor (RIP) — A raster image processor or "rip" is a highly integrated color management, page layout, and ink-handling system that provides the highest quality results from ink jet printers.

Rasterization — See Bitmapped.

Raw Formats The unprocessed black-and-white data from a digital image sensor before it has been converted or Tone Mapped into a color format that can be edited with an application like Adobe's Camera Raw Utility.

Reflected Light — The light that is reflected from the scene to the camera and meter; measured with a reflected-light meter.

Resolution — For analog photography the term is used to describe a film's ability to record fine detail. For film, good resolution is a function of sharp focus, fine grain, good contrast, and minimum exposure and development.

For digital image files, good resolution is achieved through a combination of increasing the number of pixels per inch in your image and assigning an appropriately high bit depth to each pixel.

Tagging — The process of attaching a profile to a digital image to allow it to be rendered accurately on other color-managed systems.

Textural scale — The range of five textured zones from Zone III to Zone VII.

Tonal range — The difference between the whitest white and the blackest black in a photographic print.

Tonal separation — See "Print Contrast "under Contrast.

Tone — The shades of gray, black, and white in a photographic print.

Tone Mapping — The process of converting a digital image from its raw, linear state to a format that more closely resembles a familiar non-linear distribution of tones.

Value — The light and dark areas of a photographic subject, negative, or print.

Vector-Based Images — A graphic image whose visual characteristics are created mathematically by an application line Adobe Illustrator. As opposed to a digital image composed of numerous individual picture elements or pixels.

Visualization — See Previsualization.

Zone — The basic unit of photographic previsualization and contrast measurement.

a. Any one of ten symbolic tones arranged in order from black to white. This ten-step scale is called the Zone Scale. Each zone represents a small range of tones that can be found in both the final print and the original scene.

b. A unit of photographic measurement equivalent to all other photographic controls according to a ratio of 2 to 1.

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